SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

A FLORA AND FAUNA WITHIN LIVING ANIMALS.

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COMMISSION

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INTRODUCTION.

The recent excellent works by Dujardin,[1] Diesing,[2] and Robin,[3] upon animal and vegetable parasites of living animals, render another systematic record of the labors in this field almost superfluous; and the object of the present memoir is simply to give the result of a series of observations, commenced several years ago, upon associated entozoa and entophyta, constituting a flora and fauna within animals.

The existence of entozoa, or of animals living within other species has, from the most remote time, attracted attention, on account of the peculiarity of their position, the unpleasant ideas associated with them, the sufferings they frequently induce, and the difficulty of explaining their mode of origin.

The entozoa have always constituted the strongest support of the doctrine of equivocal or spontaneous generation, one which has found distinguished disciples even to the present time; but since the days when barnacles were supposed to originate from the foam of the ocean, and ducks and geese to be developed from barnacles, this belief has been so weakened by the accumulation of facts, undenied and undeniable by the supporters of the doctrine, that it bids fair soon to be little more than an echo of the past.

The existence of vegetable parasites within animals, or of entophyta, from their minuteness, remained unknown, until the microscope of Leeuwenhoek detected the algoid filaments of the human mouth; but it is only within a comparatively recent period that any large number of distinct parasitic plants has been discovered.

The very great majority of modern observations indicate that entozoa and entophyta are produced from germs derived from parents, and having a cyclical development.

A great difficulty in determining the course of this development, particularly with entozoa, is, that their various stages of existence are passed under totally different circumstances; sometimes within one organ and then another of the same animal; sometimes in several animals; and, at other times, even quite external to and independent of the animals they infest. If, however, an entozoon preserved the same form throughout its migrations, the difficulty just mentioned would be

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[1] Histoire Naturelle des Helminthes, Paris, 1845.

[2] Systema Helminthum, Vindobonæ, 1850.

[3] Des Végétaux qui croissent sur l'homme et sur les animaux vivants, Paris, 1847.

easily overcome; but such is not the case; for the alteration of form is frequently, and probably always, so great that two successive conditions cannot be recognized as the same.[1]

When, however, entozoa have been traced to their highest condition of development, they have always been found to possess well-characterized organs of reproduction, and the females contain such multitudes of eggs as to render it no longer surprising to find intestinal worms so frequently in vast quantities. The entophyta, when fully studied, have been satisfactorily traced to sporules.

Under the circumstances above mentioned, it is very unreasonable even to suppose the necessity of spontaneous generation for animals, which, in such very numerous instances have been proved to possess as great capabilities of reproduction

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[1] Thus, almost everybody is familiar with the *Gordius*, or hair-worm, vulgarly supposed to be a transformed horse-hair. The animal is rather common in brooks and creeks in the latter part of summer and in autumn, occurring from a few inches to a foot in length. Its color passes through all shades of brown to black, and it is perfectly hairlike in its form, except that in the male the tail end is bifurcated, in the female trifurcated (American species). No one has yet been able to trace the animal to its origin! The female deposits in the water, in which it is found, millions of eggs, connected together in long cords. In the course of three weeks, the embryos escape from the eggs, of a totally different form and construction from the parents. Their body is only the 1-450th of an inch long, and consists of two portions; the posterior cylindrical, slightly dilated and rounded at the free extremity, where it is furnished with two short spines; and the anterior broader, cylindrical, and annulated, having the mouth furnished with two circlets of protractile tentaculæ and a club-shaped proboscis. No one has yet been able to determine what becomes of the embryo in its normal cyclical course. Those which I have observed, always died a few days after escaping from the egg.

The grasshoppers in the meadows below the city of Philadelphia are very much infested with a species of *Gordius*, probably the same as the former, but in a different stage of development. More than half the grasshoppers in the locality mentioned contain them; but those in drier places, as in the fields west and north of Philadelphia, are quite rarely infested, for I have frequently opened large numbers without finding one worm.

The number of *Gordii* in each insect varies from one to five, their length from three inches to a foot; they occupy a position in the visceral cavity, where they lie coiled among the viscera, and often extend from the end of the abdomen forward through the thorax even into the head; their bulk and weight are frequently greater than all the soft parts, including the muscles, of their living habitation. Nevertheless, with this relatively immense mass of parasites, the insects jump about almost as freely as those not infested.

The worms are milk-white in color, and undivided at the extremities. The females are distended with ova, but I have never observed them extruded.

When the bodies of grasshoppers, containing these entozoa, are broken and lain upon moist earth, the worms gradually creep out and pass below its surface. Some specimens which crawled out of the bodies of grasshoppers, and penetrated into earth contained in a bowl, last August, have undergone no change, and are alive at the present time (November, 1852).

In the natural condition, when the grasshoppers die, the worms creep from the body and enter the earth; for, suspecting the fact, I spent an hour looking over a meadow for dead grasshoppers, and, having discovered five, beneath two of them, several inches below the surface, I found the *Gordii* which had escaped from the corpses.

Some of the worms put in water lived for about four weeks, and then died from the growth of *Achlya prolifera*. What is their cyclical development?

The facts presented in this note serve well to show the difficulties in ascertaining the developmental history of entozoa.

as those whose cyclical development is more evident; and it remains for the supporters of the doctrine to present one single direct observation, before even its probability can be asserted.

To learn fully the nature, origin, and most favorable conditions of entozoic and entophytic life, we must commence our investigations with a clear view of the character and conditions of life in general.

An attentive study of geology proves that there was a time when no living bodies existed upon the earth.

The oblately spheroidal form of the earth, and the physical constitution of its periphery, indicate that it was once in a molten state.

A progressively increasing temperature in descending into the interior of the earth beyond the solar influence, with the phenomena of volcanoes, earthquakes, hot springs, etc., are strong evidences that the central mass of this planet yet preserves its early igneous condition.

The period which elapsed was incalculably great before the earth-crust upon its liquid nucleus had sufficiently cooled by the radiation of its heat for living beings to become capable of existing upon its surface. Not until the temperature had been reduced below the boiling point of water (212° F.), could life have originated, for water in its liquid condition is necessary to the simplest phenomenon of life. It is even highly probable that no living thing appeared upon the earth's surface until its temperature had fallen below 165°. This ordinarily is the highest point at which albumen coagulates,[1] a substance in the liquid form, probably existent in all living beings, and essential to the performance of the simplest vital phenomenon.

Living beings, characterized by a peculiar structure and series of phenomena, appeared upon earth at a definite though very remote period.

Composed of the same ultimate elements which constitute the earth, they originated in the pre-existing materials of their structure.

Living beings originate in a formless liquid matter. The first step in organization is the appearance of a solid particle. An aggregation of organic particles constitutes the spherical, vesicular, nucleolated, nucleated body, the organic cell, the type of the physical structure or organization of living beings.

The phenomena which characterize the living being are: 1. Origin, or birth; 2, nutrition and assimilation; 3, exuration;[2] 4, development and growth; 5, reproduction; 6, death. These, in the aggregate, constitute life.

The origin or birth of a living being, is the appearance of its first particle, whether directly from inorganic nature or from a parent. There is a birth to every organic cell.

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[1] Vegetable albumen coagulates from 140° to 160° F.; animal albumen, from 145° to 165°.—Turner's *Chemistry*, American edition, pp. 740, 744.

Albumen in the liquid state "on being heated to 140° begins to give indications of coagulating: if the solution is very dilute, the temperature may be raised to 165° with the occurrence of this change; and when present in very small quantity, the albumen may not separate till the fluid boils, or even until the ebullition has been prolonged for a short time."—Simon's *Chemistry of Man*, Am. ed. 1846, p. 24.

[2] *Exuro*, I consume.

Nutrition and assimilation are associated in all living actions, being coeval with the birth of a living being, and ceasing only upon its death.

During life, particles of the living structure become effete, and are removed by consumption or exuration, through the agency of the oxygen of the atmosphere. This process has been confounded with that of respiration, a function of especial organs, the lungs, branchiæ, and tracheæ, which exist in higher animals only; it is really secondary to the more important process of life, exuration. Exuration occurs in plants as well as in animals; in germination of the seed and in inflorescence it is very evident. In the growing plant, exuration is usually masked by the peculiar character and activity of the process of nutrition; but, at night, when the nutrition of the plant is at rest, the exuration becomes marked in the evolution of carbonic acid.

Development and growth are definite in each species of living being.

Reproduction perpetuates the structure as well as the species of the living being.

Death commences with life in the destruction of effete molecules of structure; it is the cessation of all life-phenomena in the individual, or is the last phenomenon of life.

To live, requires certain indispensable conditions never absent from life; always preceding it. These consist of the specific components of the living body together with the constant presence of water, air, and a definite range of temperature.

The constituent matter of living beings necessarily precedes the phenomena of life.

Without water there could be no movement to indicate life.

Air is necessary to exuration. No living being is found out of its influence. The minutest radicle of a plant never penetrates into the earth beyond the access of air.

The range of temperature necessary to life is between 35° F.[1] and 135° F.[2]

Life cannot exist independently of any one of the above-mentioned conditions. In very many instances, the removal of certain of the indispensable conditions of life-action may take place without the destruction of the power of living when these conditions are restored. Thus, many plants and animals, seeds and eggs, may be dried; yet, upon supplying moisture to them, with all the other conditions, they will again present the characteristic phenomena of life.

The indispensable conditions of life are susceptible of a great variety of modification, within a definite range, without its destruction.

Accompanying a variation of the essential conditions of life, is presented the

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[1] The so-called red-snow, *Protococcus nivalis,* Agardh., an algous plant of polar and alpine regions, grows and reproduces only upon thawing snow, though it may be found beneath virgin snow and in a temperature far below zero; nevertheless, in such circumstances it has ceased all activity, and may remain so for a long period. The plant is remarkably indestructible. I have a specimen contained in melted snow-water, yet alive and of a red color, December, 1852, which was brought by the enterprising traveller, Dr. E. K. Kane, U.S.N., from Cape Beverly, latitude 76.10, during the Grinnell expedition for 1850–51, in search of Sir John Franklin.

[2] Certain algæ grow in thermal springs, of the temperature of 117° F.

immense number of specific and individual peculiarities of living beings. The variation consists in the difference of the relative quantities of the indispensable conditions required and supplied, in addition to a modifying influence of light, probably of electricity, and possibly of some other but yet unknown agency.

The absence or presence of light is a highly important modifying condition to those indispensable to life. With the solar light, we find the green plant, which constitutes the basis of life with most terrestrial animals. Without it, the green plant and its dependent animals could not exist, but another race, now represented by certain cryptogamia, and the animal denizens of dark caverns, might inhabit the earth.

A species of plant or animal may be defined to be an immutable organic form, whose characteristic distinctions may always be recognized by a study of its history.

Any species may present individual forms not characteristic; for all, in the progress of development and course of life, are liable to modification within definite limits, which cannot be transcended without cessation of action. The original proposition is, however, not affected, for no one has ever been able to demonstrate the transmutation of one species into another.

The most ordinary and extensive modifications of species from the characteristic type are presented by arrests of development. Hence, the necessity of studying the history or cyclical course of a species in order to be capable of always recognizing it.

A modification of condition beyond the range of specific life-action, must, necessarily, result in the extinction of the species.

The study of the earth's crust teaches us that very many species of plants and animals became extinct at successive periods, while other races originated to occupy their places. This probably was the result, in many cases, of a change in exterior conditions incompatible with the life of certain species, and favorable to the primitive production of others. But such a change does not always satisfactorily explain the extinction of species.[1]

Probably every species has a definite course to run in consequence of a general law; an origin, an increase, a point of culmination, a decline, and an extinction. Within this course there may occur, under the influence of ordinary circumstances, cycles of temporary increase and diminution, until, finally, the entire machine of life of the species runs down.

The historical period of man is too short to ascertain with certainty whether such a view be correct, but it appears to be favored by analogy. The power of reproduction is limited in each individual. Plants may be reproduced to an incalculable extent by cuttings, but ultimately the power to reproduce in this manner

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[1] Thus, there are numerous instances of species of animals which have become extinct, and their place supplied by others so closely allied, that it is difficult to comprehend how the exterior conditions for their existence should be so different; as in the case of the *Equus primigenius*, *E. Americanus*, &c., which have given place to the *E. caballus*, the *Bos primigenius*, whose place is supplied by the *Bos taurus*, the *Bison latifrons* by the *Bison Americanus*, &c.

becomes exhausted. The perennial plant puts forth phyton after phyton, but the seed is necessary to its perpetuation. Numerous lower animals are reproduced to a vast extent by segmentation or allied processes, but ultimately a recurrence to sexual admixture becomes necessary for the preservation of the species.[1] Sexual admixture, limited to a few families of a species, soon ends in their extinction. Finally, the complex living being, from birth to death, produces an immensity of living organisms, the organic cells; but the egg and seed are necessary to insure the species against extinction.

Living beings did not exist upon earth prior to their indispensable conditions of action, but wherever these have been brought into operation concomitantly, the former originated; and for such an immensity of time and vastness in quantity, have they existed, that most of the superficial rocks of the earth's crust are composed of their remains.

The stratum of life has been always subjected to the destructive agency of earthquakes, volcanoes, and torrents; but it is wonderful how soon, under the play of the life-conditions, the new surface again teems with living beings. Here and there, upon the wide area of the earth, an igneous rock peeps out as if to observe the monopoly of life, but even this, in the progress of time, has its steep sides hidden by lichens and its summit enveloped in verdure.

Of the life, present everywhere with its indispensable conditions, and coeval in its origin with them, what was the immediate cause? It could not have existed upon earth prior to its essential conditions; and is it, therefore, the result of these?

There appear to be but trifling steps from the oscillating particle of inorganic matter, to a *Bacterium;* from this to a *Vibrio,* thence to a *Monas,* and so gradually up to the highest orders of life! The most ancient rocks containing remains of

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[1] Instances in favor of this view are numerous; among others, I have met with a striking example in the case of a worm, to which I have given the name of *Stylaria fossularis* (Proc. Acad. Nat. Sci. V. 287). This worm is found abundantly in ditches in the neighborhood of Philadelphia, during warm weather, and is constantly observed to be undergoing division. Individuals, a third of an inch long, are usually found to consist of two divisions, and occasionally of three, in various stages of progress towards separation. The divisions are composed of about twenty-two annulations, each possessed of a pair of fasciculi of five podal spines and two bristles. The head consists of a large lobe, with a long digit-like appendage, and presents an eye upon each side of a large mouth. The latter opens into a capacious pharynx, which afterwards contracts into a cylindrical œsophagus, continuous with a well-developed intestine, but within the animal no trace of a generative apparatus can be perceived.

In the course of a season, a single individual may reproduce some millions simply by segmentation; but as cold weather approaches, we find the animal to lose this power—not resulting from the influence of the cold, but from exhaustion of the power; because, even if the worms be placed in a warm situation, as in the window of a warm room, where the sun may shine upon the vessel containing them, they are observed to cease division. The loss of power of this mode of reproduction, is, however, compensated for by another succession of developments.

The worms grow to an inch in length and are composed of sixty annulations, each being provided with double the previous number of podal spines. Within the body, an androgynous generative apparatus becomes developed; within the ovaries are developed ova, and within the testis, spermatozoa. Two individuals copulate, eggs contained in bottle-shaped cases are extruded, and ultimately the parent dies.

After some weeks, in a warm situation, the ova are hatched, the young escape and move freely about, and soon commence to reproduce their numbers by division.

living beings, indicate the contemporaneous existence of the more complex as well as the simplest of organic forms; but, nevertheless, life may have been ushered upon earth, through oceans of the lowest types, long previously to the deposit of the oldest palæozoic rocks as known to us!!

The primitive species of living beings which appeared upon earth, and those which have been successively and periodically produced, must have been the result of pre-existing natural conditions, or the former alone originated in this manner, and the latter were the result of their transmutation under the influence of varying exterior conditions, or all species in all times originated directly through supranatural agency.

The last mode, of course, can only be an inference, in absence of all other facts; and if living beings did not originate in this way, it follows they are the result of natural conditions.

Be this as it may, the most prolonged and closest observations, and the most carefully conducted experiments have not led to the proof of a single instance of spontaneous or equivocal generation even of one of the simplest of all living beings; but, on the contrary, they all lead farther and farther from or entirely disprove it, and thus involve the whole subject in obscurity.

Schulze[1] performed an experiment to test the possibility of equivocal generation under the play of the indispensable conditions of life, free from access to any pre-existing vegetable or animal germs.

A glass vessel half filled with a mixture of various dead vegetable and animal substances in water, was heated to 212° F., so as to destroy any living bodies which might exist within. To the vessel was then adapted a pair of Liebig's bulbs, one of which contained sulphuric acid, the other a solution of potassa, and through these only could the exterior air have access to its interior. The apparatus was then placed in a window, where it received the full influence of light and the necessary temperature for the production of life. The air within the vessel was daily renewed from May until August, by blowing through the sulphuric acid, from which it could suffer no change, except to be deprived of moisture and organic particles. During all that time, not even the simplest animal or vegetable forms were produced, while in an open vessel containing the same mixture, in the same situation, there were observed on the following day numerous Vibrios and Monades, and to these were soon added larger animalculæ.

This interesting experiment of Schulze, I repeated with three different vessels; in one of which was a mixture of ditch-mud and confervæ with water; in a second, decaying wood with water; and, in the third, a clod of earth with growing grass, earth-worms, and water. Exactly under the same circumstances, they were supplied with fresh air from time to time, from July of 1850 to December of 1851, and in the end the results were the same as in the experiment of Schulze.

These experiments, however, may not be conclusive; other conditions may be

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[1] Notice of the Result of an Experimental Observation made regarding Equivocal Generation. By F. Schulze, Berlin. The *Edinburgh New Philosophical Journal*, vol. xxiii. 1837, p. 165.

required; what might have been the influence of a long-continued current of electricity, under the same circumstances, upon the mixtures?

The experiments of Crosse and Weekes, in the production of the so-called *Acarus Crossii*, were performed under the least favorable circumstances to the origination of life, and, although neither an Acarus nor a Homunculus has been created under the inspection of man, yet ridicule or prejudice should not prevent us from making every observation and experiment which can bear on the subject, in order that we may say positively whether living beings do or do not originate from the inorganic world under natural and still-existing conditions.[1]

To the present, we are totally unacquainted with the mode of the primitive origin of living beings!

Each species once in existence, very generally, and probably universally, requires two distinct elements, denominated sexual, for its perpetuation.

The power of reproduction by segmentation, budding, or the production of numerous successions of asexual fertile generations is, probably, in all cases limited; the species necessarily reverting to sexual admixture for its perpetuation.

The statements of Horkel[2] and Schleiden,[3] and their followers, that true sexes do not exist in the phanerogamia have been most amply refuted by the more careful observations of Amici,[4] Hugo von Mohl,[5] Carl Müller,[6] Hoffmeister,[7] Gasparini,[8] Tulasne,[9] and others.

Sexual elements have also been detected in most of the cryptogamia, and, in a little time, will probably be discovered in all. They have been observed in Ferns,[10] Mosses,[11] and Algæ,[12] but not yet among Fungi.

Having thus taken a cursory glance at the laws of life in general, we have next to consider those especially operating in the production of parasitic life.

Within living beings, *i. e.* within their cavities or the parenchyma of the organs,

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[1] The experiments of Crosse and Weekes appear to me exceedingly absurd; for, in the first case, how were the carbon and nitrogen of the animal body to be derived by the play of a voltaic current upon a solution of silicate of potassa? If they previously existed in the water, was it not quite as probable that the ova of Acari were there also? Again, when the solution of ferrocyanide of potassium was made the womb of life by the electrical current, why could not the embryology of the new being be observed? An Acarus is a highly complex animal, presenting a well-developed tegumentary, muscular, and nervous system, and a digestive, respiratory, and generative apparatus. The gap between the inorganic world and the Acarus is greater than that between the latter and man!

[2] Monatsb. d. Berlin. Akad. 1836.

[3] Archiv f. Naturges. 1837; Nova Acta C. L. C. Acad. Nat. Cur. vol. xix. 1839, p. 27; Grundzüge d. Wissenschaftliche Botanik.

[4] Giornale botanico Italiano, An. 2; Annales des Sciences Naturelles, Botanique, 1847, t. vii. p. 193.

[5] Botanische Zeitung, 1847; An. Sc. Nat., Bot. t. ix. 1848.

[6] Ibid.

[7] Ibid. and t. xi. 1849.

[8] Ibid.

[9] Ibid. t. xii. 1849.

[10] Tulasne, ibid. t. xi. p. 5; ibid. p. 114.

[11] Schimper: Recherches Anatom. et Morpholog. sur les Mousses. Strasbourg, 1848. This author says, page 55: "*Mais je tiens le fait que jamais une mousse ne parvient à la fructification quand elle se trouve hors de l'influence des organes que je considère comme des organes mâles.*"

[12] Thwaites, in *Annals and Magazine of Natural History*, 1847, vol. xx. p. 9; ibid. p. 343; ibid. 1848, 2d ser. vol. i. p. 161.

of course all the indispensable conditions of life exist, and consequently we cannot wonder at their being infested with other living beings adapted to their parasitic position. Nevertheless, although the conditions of life are necessarily ever present in living beings, yet these frequently do not contain parasites. There are many circumstances besides those essential to life in general, which influence the existence or non-existence of such forms. One of the most important of these circumstances is the convenience or ease of access, or of entrance to the living body infested.

Within the living, closed, organic cell parasites very rarely if ever exist, because it is liquid matter only which can endosmose through cell-membrane, and, therefore, solid germs cannot enter,[1] and hence the unfrequency of true entozoa in vegetables. Entozoa may and do penetrate through living tissues, but it is entirely by the mechanical process of boring.

The intestinal canal of animals is most frequently infested by entoparasites on account of the ease with which their germs enter with the food.

Aquatic animals are more troubled by entozoa than those which are terrestrial, because the water affords a better medium of access than the air.

Terrestrial animals, on the other hand, are more infested by ectoparasites because their covering of hair, wool, and feathers is more favorable to their protection and reproduction. A low degree of organic activity and slowly digestible food favor the development of entoparasites, and hence they are more frequent in the relatively sluggish herbivora than in the carnivora. Comparatively indigestible food, and such as contains but a small proportion of nutritive matter, from its long retention in the alimentary canal, favors the development of entozoic and entophytic germs more than that in which the contrary conditions prevail.[2]

Animals subsisting upon the endosmosed juices of the tissues of other animals, and of plants, are rarely infested by parasites, as in the case of the hemipterous insects, aphides, etc., because such food is necessarily free from parasites or their germs. Entozoa themselves, on this account, are not infested.

On the other hand, if the liquid food be open to the air, parasitic germs may be readily introduced into the animal, as in the case of the common house-fly, which often contains myriads of a species of *Bodo*.

Food swallowed in large morsels favors the introduction of attached parasites; hence these are frequently found in reptiles, and even in birds, which are, among the vertebrata, of the highest organic activity.

Animals of feeble organic activity using solid food, which is very slowly digested,

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[1] In some experiments upon the endosmosis of solid matter through organic cell-membrane, I found that particles of carmine, diffused in water, which I estimated to measure about the 52,000th of an inch, would no more penetrate the cell-membrane than the largest masses.

[2] The inhabitants of the United States appear to be less infested with entozoa than those of any other part of the world. This probably arises to a great extent from the more nutritious character of their food; even the poorest laborer being daily supplied with abundance of wholesome flesh, producing a tendency to high organic activity, which is unfavorable to parasitic development.

and contains little nutriment, are rarely free from parasites. This is the case with the coleopterous insect *Passalus*, and the myriapod *Julus*.

Cooking food is of advantage in destroying the germs of parasites; and hence man, notwithstanding his liability to the latter, is less infested than most other mammalia. Did instinct originally lead him to cook his food, to avoid the introduction of parasites?

Entozoa are more abundant than entophyta, because the power of voluntary movement favors them in their transmigrations, and renders them less liable to expulsion from the intestinal canal.

Influence of Parasites in the Production of Disease.—In many animals entozoa and entophyta are almost never absent, and probably when in their natural habitation, and few in number, or not of excessive size, are harmless, as observed by Dujardin in the introduction of his excellent work on Intestinal Worms: "Les helminthes se développent dans un site qui leur convient, sans nuire plus que les lichens sur l'écorce d'un arbre vigoureux. Ils ne peuvent devenir nuisibles, généralement, que par suite d'une multiplication excessive, laquelle semble alors être une des conséquences d'un affaiblissement provenant d'une tout autre cause, d'une mauvaise alimentation, du séjour dans un lieu froid et humide, etc.: sans cela, les helminthes naissent et meurent dans le corps de leurs hôtes, et peuvent paraître et disparaître alternativement sans inconvénients."

Many important diseases have been supposed to originate from parasitic animals and vegetables. The former are not the true entozoa, for these are too large, and may be detected by the naked eye, but they are considered to be animalculæ so small that they cannot be discovered even with the highest powers of the microscope. But, independent of the fact that the existence of such entities is a mere suspicion, none of the well-known animalculæ are poisonous. At various times, I have purposely swallowed large draughts of water containing myriads of *Monas*, *Vibrio*, *Euglenia*, *Volvox*, *Leucophrys*, *Paramecium*, *Vorticella*, etc., without ever having perceived any subsequent effect.

The production of certain diseases, however, through the agency of entophyta, is no longer a subject of doubt; as in the case of Muscardine in the Silk-worm, the Mycoderm of Porrigo favosa in Man, etc.; but that malarial and epidemic fevers have their origin in cryptogamic vegetables or spores requires yet a single proof.[1] If such were the case, these minute vegetables and spores, conveyed through the air, and introduced into the body in respiration, could be detected. The minutest of all known living beings is the *Vibrio lineola* of Müller, measuring only the 36,000th of an inch, and the smallest known vegetable spore is very much larger than this, whilst particles of inorganic matter can be distinguished the 200,000th of an inch in size.

I have frequently examined the rains and dews of localities in which intermittents were epidemic upon the Schuylkill and Susquehanna Rivers, but without being able to detect animalculæ, spores, or even any solid particles whatever. I

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[1] See an ingenious little work by my distinguished friend Dr. J. K. Mitchell, "On the Cryptogamous Origin of Malarious and Epidemic Fevers."

have examined the air itself for such bodies, by passing a current through clear water. This was done by means of a bottle, with two tubes passing through a cork stopper; one tube dipping into the water, the other reaching not quite to its surface. By sucking upon the latter tube, a current of air passed through the former, and was deprived in its course of any solid particles. Ordinarily, when the atmosphere was still, early in the morning, or in the evening, neither spores nor animalcules could be detected. When piles of decaying sticks or dry leaves were stirred up, or the dust was blown about by the wind, a host of most incongruous objects could be obtained from the air; none, however, which could be supposed capable of producing disease.

To assert, under these circumstances, that there are spores and animalculæ capable of giving rise to epidemics, but not discernible by any means at our command, is absurd, as it is only saying in other words that such spores and animalculæ are liquid and dissolved in the air, or in a condition of chemical solution. That the air may be poisoned by matters incapable of detection by the chemist is proved by the emanations from such plants as the *Rhus vernix, Hippomane mancinella,* etc.

Parasites of Man.—The list of described species of parasitic animals and plants to which man is liable is already a long one, but nevertheless, in different parts of the world, others will yet be discovered. According to the most authentic sources, the known species are as follow:—

ENTOZOA HOMINIS.

Filaria medinensis, Gmelin. Subcutaneous areolar tissue.
Filaria bronchialis, Rudolphi. Bronchial glands.
Filaria oculi humani, Nordmann. Eye.
Tricocephalus dispar, Rud. Large intestine.
Strongylus gigas, Rud. Kidneys.
Ascaris lumbricoides, Lin. Small intestine.
Ascaris alata, Bellingham. Small intestine. (Ireland.)
Oxyuris vermicularis, Bremser. Rectum.
Spiroptera hominis, Rud. Urinary bladder.
Ancyclostomum duodenale, Dulimi. Small intestine.
Trichina spiralis, Owen. Muscles.
Pentastomum constrictum, Siebold. Small intestine and liver. (Egypt.)
Bothriocephalus latus, Bremser. Intestines.
Tænia solium, L. Small intestine.
Tænia nana, Siebold. Small intestine and liver. (Egypt.)
Monostomum lentis, Gescheidt. Crystalline lens.
Distomum hepaticum, Abilgaard. Gall-bladder and portal vein.
Distomum lanceolatum, Mehlis. Hepatic duct.
Distomum oculi humani, Gescheidt. Capsule of crystalline lens.
Distomum hæmatobium, Bilharz. Portal Vein. (Egypt.)
Distomum heterophyes, Siebold. Small intestine. (Egypt.)
Tetrastomum renale, Chiaje. Kidney.
Hexathyridium pinguicola, Treutler. Ovary.
Hexathyridium venarum, Treut. In the veneus blood.
Cysticercus cellulosæ, Rud. Areolar tissue of various organs.
Echinococcus polymorphus, Diesing. Various viscera.

ECTOZOA HOMINIS.

Phthirius inguinalis, Leach. (Crab-louse.)
Pediculus capitis, Nitzsch. (Head-louse.)
Pediculus vestimenti, Nitzsch. (Body-louse.)
Pediculus tabescentium, Burmeister.
Sarcoptes scabiei, Latreille. (Itch-insect.)
Demodex folliculorum, Owen.
Dermanyssus Boryi, Gervais.
Ixodes americanus, De Geer. (Tick.)
Argas persicus, Fischer.
Pulex irritans, Lin. (Common flea.)
Pulex penetrans, Gmelin. (Chiggo.) South America.
Cimex lectularius, Lin. (Bed-bug.)
Oestrus hominis, Say. South America.

ENTOPHYTA HOMINIS.

Alga of the mouth.
Achorion Schönleinii, Remak. In porrigo favosa.
Achorion Lebertii, Robin. In porrigo scutulata.
Microsporium Audouini, Gruby. In porrigo decalvans.
Mycoderm of Plica Polonica.
Mycoderm of Mentagra.
Mycoderm of Muguet.
Mycodermata of ulcerated and mucous surfaces.
Sarcina ventriculi, Goodsir. Stomach.
Torula?[1] Stomach.

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[1] I once saw a plant of this kind in great abundance mingled with the *Sarcina ventriculi* in the liquid ejected from the stomach of a man.

CHAPTER I.

DESCRIPTION OF A FLORA WITHIN ANIMALS.

THE most extensive associated flora and fauna which I have discovered within animals exists with wonderful uniformity within the intestinal canal of the Myriapod, *Julus marginatus*, Say, and of the Coleopterous insect, *Passalus cornutus*, Fabricius; and in order that the position of the parasites in relation to the different portions of the intestines may be clearly understood, I have considered it proper to give a short anatomical description of the latter.

§ 1.—OF THE ANATOMY OF THE INTESTINAL CANAL OF JULUS MARGINATUS.

(PLATE VII. Fig. 2I.)

The alimentary canal of *Julus marginatus*, though extending in a straight line from mouth to anus, is very large and capacious in relation to the size of the animal, and is in accordance with the nature of the food.

Opening into the pharynx there are six *salivary glands* (Plate VII.), two of which are pyriform (*a*), conglomerate, and cellular in structure, and placed one upon each side of the œsophagus; the others are long and tubular (*b*).

The *œsophagus* is pyriform and capacious (*c*). The *proventriculus* (*d*) forms nearly half the length of the alimentary canal. It is capacious, cylindroid, and dilates very gradually from its lower third to its termination. Its lower extremity is constricted into six annuli, of which the last is twice the width of the others. The mucous membrane of the proventriculus is smooth, ochreous-yellow in color, and opaque. At the termination of the proventriculus, there open two *biliary tubes* (*e*), and from it, surrounding the commencement of the ventriculus, is suspended a broad, white, opaque, reticulated band (*f*), apparently composed like the rete adiposa of insects.

The *ventriculus* (*g*) forming about one-sixth the whole length of the alimentary canal, is simple, cylindrical, or intestiniform, and is narrower than the proventriculus, and stronger. Upon its exterior surface, it presents several slightly tortuous elevated longitudinal lines. Its lining membrane is smooth, and at the commencement of the organ is provided with a single transverse row of thin, quadrilateral corneous plates.

The *large intestine* (*h*) commences very abruptly; at first being nearly twice the breadth of the ventriculus; but at its lower half, it gradually decreases to its

termination in the rectum, where it is as narrow as the ventriculus. Its parietes present a great number of slight depressions, arranged in quadrangular groups, which latter form longitudinal rows the whole length of the large intestine.

The *rectum* (*i*) is short, elliptical, and presents several narrow internal longitudinal folds or elevated lines, continuous with the longitudinal lines of separation of the rows of quadrangular groups of depressions of the large intestine.

It is within the ventriculus, the large intestine, and the rectum, that the extensive Julidean flora and fauna are found.

§ 2. Of the Anatomy of the Intestinal Canal of Passalus cornutus.

(Plate VI. Figs. 8–10.)

The intestinal canal of *Passalus cornutus*, in accordance with the nature of the animal's food, is capacious, and about three times the length of the body.

The *œsophagus* extends in a straight line as far back as the mesothorax, is capacious and claviform, gradually widening to its posterior fourth, and then narrowing to its termination in the *proventriculus*.

The latter (Pl. VI. Fig. 8, *a*) constitutes about two-thirds of the whole length of the alimentary canal. It makes several transversely circular convolutions within the abdomino-thoracic cavity; it is capacious, and, with the exception of its commencement, which is a little dilated, claviform, is nearly uniformly cylindrical throughout. The mucous membrane of the proventriculus, with the exception of a small portion of its posterior extremity, is studded pretty closely with white circular glands, arranged, though not very regularly, in alternating rows; which, through the translucent parietes of the organ, give it a white maculated appearance. At the junction of the proventriculus with the ventriculus open four biliary tubes.

The *ventriculus* (Fig. 8, *b*; Fig. 9), which in *Passalus* always contains entophytic forests, makes a sigmoid turn from the left backwards, and to the right side. It is one-third broader than the proventriculus; and, for the most part, is constituted of six longitudinal rows of transversely oval sacculi separated by as many intervening folds or ridges. The sacculi are about twenty in number, in each row, separated by transverse folds; they open into the interior of the organ (Fig. 10, *a*). At the commencement of the ventriculus, upon the left side, there projects an oval, curved, *cæcal pouch* (Fig. 9, *b*), apparently formed by the conjunction of two of the ventricular sacculi, though as large as four of them. Within the ventriculus, the lateral borders of the longitudinal folds (Fig. 10, *b*), separating the sacculi, between the transverse folds (*c*), are thickly set with simple, bidentate, and tridentate, amber-colored, corneous spines (Pl. IX. Fig. 1, *d*). These are arranged in two separate and close columns, convergent forwards, and extending backwards in a straggling manner between the ventricular sacculi. Besides these spines, the surface of the mucous membrane is everywhere studded with distant, stiff, corneous, yellow, translucent, hair-like appendages, which, at the edges of the ventri-

cular sacculi, are relatively of considerable length, measuring from the 400th to the 125th of an inch in length, by the 3000th of an inch thick, while the others measure the 1154th of an inch in length.

At the termination of the saccular structure posteriorly, the lining membrane of the ventriculus is provided with a single transverse row of six broad, V-shaped corneous plates (Fig. 10, *d*), followed, after a short interval at the junction of the organ with the fecal intestine, by a thin, yellowish, corneous annulus.

The *fecal intestine* (Fig. 8, *c*) is cylindrical, narrower, and more strongly muscular than the proventriculus, and performs nearly the complete circuit of the abdomen in its course to the anus.

§ 3. Description of the Genus and Species of Enterobryus.

ENTEROBRYUS, Leidy.

Thallus attached, consisting of a single, very long, tubular cell, filled with granules and globules, producing at its free extremity one, usually two, rarely three, shorter tubular cells, and growing at the other end from a relatively short, cylindroid, amorphous, coriaceous pedicle, commencing with a discoidal surface of attachment.

1. Enterobryus elegans, Leidy.

Proc. Acad. Nat. Sci., Phila., iv., 225.

(Plate I. Fig. 1; II.; III. Figs. 1–14; IV. Figs. 1–25, 28.)

Thallus olive brown, brownish, yellowish, or colorless, transparent, cylindrical, usually somewhat clavate at the free end; at first forming a single spiral turn, and then proceeding in a straight or gently flexuose curved line to the free extremity. *Pedicle* variable in length to that of the thallus, cylindroid, more or less transversely contorted, finely striated longitudinally, uniformly brownish in color, commencing in a broad discoidal expansion. *Principal cell* very long, cylindrical, slightly dilated at the commencement, and usually more so, or somewhat clavate at the free end. *Penultimate cell* cylindrical. *Terminal cell* shorter than the last, cylindroid, clavate, curved, obtusely rounded at the extremity.

Whole length, 2 to 3 lines. Length of pedicle $\frac{1}{3750}$ to $\frac{1}{400}$ of an inch; breadth $\frac{1}{3200}$ to the $\frac{1}{1666}$ of an inch. Breadth of principal cell, the $\frac{1}{935}$ of an inch. Length of penultimate cell, $\frac{1}{100}$ to the $\frac{1}{80}$ of an inch; breadth, $\frac{1}{1000}$ to $\frac{1}{950}$ inch. Length of terminal cell, $\frac{1}{150}$ to $\frac{1}{125}$ inch; breadth, $\frac{1}{1000}$ to $\frac{1}{625}$ inch.

Habitation. Parasitic, growing from the basement-membrane of the mucous membrane of the small and large intestine of *Julus marginatus*, Say; and from any part of the exterior of *Ascaris infecta*, *Streptostomum agile*, and *Thelastomum attenuatum:* entozoa infesting the cavities of the viscera, just mentioned.

2. Enterobryus spiralis, Leidy.

Proc. Acad. Nat. Sci., Phila., iv., 249.

(Plate I. Fig. 4.)

Thallus brownish, yellowish, or hyaline, cylindrical, forming a single, double, or triple spiral. *Pedicle* cylindroid, expanded at base, or elongated conical, not contorted, smooth, or faintly striated longitudinally, brownish or yellowish in color. *Principal cell* cylindrical, slightly dilated at the extremities or uniform throughout. *Penultimate cell* cylindrical. *Terminal cell* clavate, curved, obtuse.

Whole length, from $\frac{1}{70}$ to $\frac{1}{50}$ inch. Length of pedicle, $\frac{1}{2500}$ inch; breadth, $\frac{1}{6000}$ to $\frac{1}{4200}$ inch. Breadth of principal cell, $\frac{1}{4285}$ inch. Length of penultimate cell, $\frac{1}{450}$ to $\frac{1}{400}$ inch; breadth, $\frac{1}{4285}$ inch. Length of terminal cell, $\frac{1}{550}$ to $\frac{1}{500}$ inch; breadth, $\frac{1}{3333}$ inch.

Habitation. Attached to the mucous membrane of the small intestine of *Julus pusillus.*

3. Enterobryus attenuatus, Leidy.

Proc. Acad. Nat. Sci., Phila., iv., 249.

(Plate I. Figs. 2, 3; Pl. III. Figs. 15–17; Pl. IV. Figs. 26, 27.)

Thallus faintly brownish, yellowish, or hyaline; forming at first a double flexure or sigmoid curve, and then proceeding in a straight or gentle curvilinear direction to its free extremity. *Pedicle* short, cylindroid, campanulate, or conical with a spreading base, longitudinally striated, simple, occasionally double, uniformly yellowish. *Principal cell* cylindrical, attenuated at both extremities, or very slightly and gradually narrowing from the commencement, or uniform throughout; truncated, or obtusely rounded at the free extremity. *Terminal cells* rare.

Whole length $\frac{1}{2}$ line to 1 line. Length of pedicle $\frac{1}{666}$ to $\frac{1}{600}$ inch by $\frac{1}{2300}$ to $\frac{1}{2000}$ inch broad. Diameter of principal cell; at middle, $\frac{1}{1500}$ inch; at sigmoid curve, $\frac{1}{2300}$ inch; at the free extremity, $\frac{1}{2500}$. In other instances, $\frac{1}{715}$ inch at the sigmoid portion, and gradually decreasing to $\frac{1}{1100}$ inch at the free end. Where uniformly cylindrical, about the $\frac{1}{1700}$ inch in diameter.

Habitation. Grows from the mucous membrane of the ventriculus of *Passalus cornutus.*

§ 4. History, Structure, etc. of Enterobryus.

I first discovered the genus of entoparasitic plants, *Enterobryus,* in the small intestine of *Julus marginatus,* in the autumn of 1848, but published no account of it until October of the following year. From its structure, I immediately supposed it to be a plant; but afterwards, from the constancy of its existence in the small intestine, and firmness of attachment to the mucous membrane of the latter, I began to suspect it might be a part of the structure of the viscus in which it was

found, of the character of villoid appendages. It then occurred to me that if it were a plant, it would probably be also found upon fragments of the ligneous food of the animal within the intestine, which, however, was not the case. On the other hand, I frequently detected it growing from the exterior surface of three species of nematoid entozoa infesting the alimentary canal of *Julus marginatus* with as much constancy as the plant itself. Among several hundred specimens of these worms, consisting of *Ascaris infecta*, *Streptostomum agile*, and *Thelastomum attenuatum*, which I had obtained from numerous individuals of *Julus marginatus*, and preserved in alcohol, I found twenty which had from one to a dozen filaments of *Enterobryus* attached to their exterior surface. Since then, I have observed that on an average about one in twenty of the entozoa will be found to have the plant growing upon it. In one instance, I found a large individual of *Ascaris infecta*, with twenty-three filaments of *Enterobryus* growing from its surface, which appeared to cause no inconvenience to the animal, as it moved and wriggled about with all the ordinary activity of the species (Pl. VI. Fig. 1).

The plant rarely reaches its full growth upon the entozoa, although its attachment is as firm as upon its ordinary seat, the mucous membrane of the cavity infested by the worms.

The principal and constant locality of the *Enterobryus*, and that in which it is most frequently met with in full development, in *Julus marginatus*, is at the commencement of the ventriculus (Pl. VII. Fig. 21, *g*). Lower down it is not so abundant; nor is it in this position usually of large size. In the large intestine (*h*), especially at the lower extremity, it frequently exists in the greatest profusion, but always in a very immature condition.

From the constancy of the presence of *Enterobryus elegans* within *Julus marginatus*, having examined over one hundred of the latter without finding it absent even in a single instance, I was led to suspect its existence within other species of *Julus*, and accordingly sought for it in *Julus pusillus*, a species very much smaller than *Julus marginatus*. Within this I detected the second and smallest species, the *Enterobryus spiralis*.

I found no entozoa within a dozen individuals of *Julus pusillus*, nor did the *Enterobryus* always exist in it; in several there were only two or three filaments; in two others it grew profusely; and in two it was not at all present.

From the occurrence of two species of *Enterobryus* in the two species of *Julus* examined, I suspected entophyta would be found very commonly among the Myriapoda. I therefore examined species of *Cermatia*, *Cryptops*, *Scolopendra*, *Geophilus*, *&c.*, but in none of these carnivorous genera did I discover a trace of a parasitic plant. In two species, however, of another genus of herbivorous Myriapoda, *Polydesmus granulatus*, and *Polydesmus virginensis*, I found two new and distinct species of entophyta, which I have referred to a different genus from *Enterobryus*, under the name of *Eccrina*, of which a description will follow hereafter.

Pursuing my researches after entophyta among insects next, I found none among the Hemiptera, nor the carnivorous Coleoptera, but in our most common, largest

herbivorous coleopterous insect, *Passalus cornutus*, resembling very much in its habits the *Julus marginatus*, and like it, living in decaying stumps of trees, I found a constant and most extraordinary profusion of vegetation, only equalled by that of *Julus marginatus*, among which was the third and very graceful species, the *Enterobryus attenuatus*.

1. *Of the Principal Cell of Enterobryus.*—(Pl. I. Fig. 1, *b*; 3, *b*; 4, *c*.) This is a very long, tubular, cylindrical cell, closed at the extremities. The end attached to the pedicle is set or received into a concavity, and is usually slightly dilated beyond the general diameter of the cell. (Pl. III. Fig. 11, *a*.) The distal end is usually more or less dilated or clavate and obtusely rounded (4), or it is abruptly truncated (17).

In *Enterobryus attenuatus* (Pl. I. Fig. 3) the cell is sometimes narrowed from the middle towards both extremities; at other times from the sigmoid flexure towards the distal end; but frequently is nearly uniform in its diameter throughout.

The cell-wall is amorphous in structure, thin, coriaceous, strong, flexible, very slightly elastic, perfectly transparent, usually colorless—always so in young specimens—frequently amber-colored, or yellowish or brownish, and occasionally dark brown. Its thickness is pretty uniform, except at the extremities, where it is rather thicker than at the sides. Its usual average is about the $\frac{1}{6000}$ of an inch.

In *E. attenuatus*, the cell-wall is sometimes twice as thick at the sigmoid flexure of the thallus as elsewhere; in the former position measuring the $\frac{1}{5000}$ of an inch, in the latter the $\frac{1}{10000}$ of an inch. When the distal extremity of the principal cell has no secondary ones attached, and is truncated, the cell-wall forming the margin of the extremity is increased in thickness sometimes to a triple extent, and occasionally projects beyond the general outline of the cell (Pl. III. Fig. 17, *d*). In these latter cases, the cell-wall forming the terminal face of the truncated extremity of the cell is sometimes so very thin that it appears as if the permanent cell-wall ceased at the margin of the extremity, and the internal, very delicate, transparent, colorless, mucoid bounding layer between the permanent cell-wall and the cell-contents, or the primordial utricle of Hugo von Mohl, protruded from the open end, resembling the crystal upon the face of a watch (Pl. II. Fig. 4, *b*; III. 7). Generally, however, it is observed that the cell-wall at the truncated extremity, though thin, is sufficiently strong to prevent the appearance described. In those cases in which the distal end of the principal cell of *Enterobryus* is clavate, with or without attached secondary cells, the cell-wall is thicker at that than at any other portion of the cell.

The cell-contents consist of a hyaline, or occasionally a faint amber-colored mucoid or albuminoid fluid, or protoplasma, with granules and globules of various sizes (Pl. III.).

It is only in the youngest individuals of *Enterobryus* that the principal cell usually contains a large quantity of the protoplasma. Ordinarily, at all more advanced ages, it is distended with fine and coarse granules and large globules, the intervals only being occupied by a relatively small proportion of protoplasma.

The granules are more or less minute, transparent, colorless, or occasionally faintly yellowish, spherical bodies, measuring from a mere point to the $\frac{1}{10000}$ of an inch in diameter (Fig. 10). They exist in variable quantity within the principal cell, usually more or less enveloping the globules, but never to such an extent as to exclude the latter, although they are themselves sometimes reduced to a few scattering points among a mass of globules. Usually, they are most abundant at the bottom or commencement of the cell (Figs. 6, 9), and rapidly diminish towards the distal extremity of the latter. Sometimes they are abundant at the bottom (Fig. 6), and do not exist at all near the distal end of the cell (Fig. 4); at other times they are found at both ends but none in the middle (Figs. 1–3); and lastly, they are occasionally met with towards the distal extremity of the cell only.

These granules somewhat resemble oleaginous particles in appearance; they are highly refracting, and are more dense than the surrounding protoplasma.

The globules, as I technically designate them, are colorless, transparent, spherical, polyhedral, or oblong bodies. When spherical, they are always accompanied by a more or less large quantity of protoplasma and granules (12). When polyhedral they exist in large number, and the form appears as an alteration from the spherical produced by mutual pressure (2, 14). When oblong, their long diameter is generally parallel to the length of the cell containing them, and ascends to three or four times that of the transverse diameter, which in such cases is always that of the caliber of the cell (Pl. II. 4; III. 8). Sometimes they are met with transversely oblong (2), the long diameter equal to the caliber of the cell, the short diameter always less than the latter, the form being apparently produced by upward pressure.

In size, the globules usually measure from one-sixth to the whole diameter of the caliber of the containing cell.

Sometimes they exist almost to the entire exclusion of the ordinary granular matter, or even the intervening protoplasma (Pl. II. 1; III. 2, 13, 14). Sometimes they are of remarkably uniform size in the same cell, though very variable in this respect in different cells (17); frequently, however, they vary very much in size within the same cell (Pl. II. 4). Occasionally, a single row of large globules distends the cell nearly throughout its whole length (Pl. III. 13); at other times, three or more rows are observed, polyhedral in form, regularly alternating with one another (17) through the whole course of the tube, if the latter remains uniform in diameter, or cylindrical; should the tube become clavate, or more dilated at the distal end, it is always attended by an increase in the relative number of globules (4).

In physical structure, the globules appear to be composed of a somewhat viscid, amorphous, hyaline, albuminoid liquid, inclosed within an immeasurably thin, amorphous membrane, apparently a delicate film of coagulated protoplasma, holding a mass of the same substance in a liquid condition.

Upon the application of a weak solution of iodine in water to the living thallus of *Enterobryus*, a movement is observed to take place in the contents of the principal cell in an upward direction, or towards the distal end, apparently as if the cell-wall were contracting, and there was less resistance anteriorly than posteriorly, and the cell-contents were consequently pushed in the former direction. A moment

after, however, the movement is reversed, the globules successively burst, and become at first faintly purplish, and afterwards brownish. The protoplasma and granules are colored a deep or intensely reddish brown.

With nitric acid, and the subsequent addition of aqua ammonia, the cell-contents become a confused mass of a beautiful amber color.

Solution of iodine, acetic acid, solution of chloride of sodium, aqua ammonia, or the long-continued action of water, give rise to a destruction of the different parts of the cell-contents, and causes a general shrinking of the mass from the inner surface of the cell-wall, the whole apparently held together by the continuity of the primordial utricle, which now presents a shrivelled, faintly granular appearance (IV. 2).

Occasionally, dead individuals of *Enterobryus* are met with in which the cell-contents are observed to have shrunk to two-thirds or even one-third their original extent, presenting a shrivelled, irregular, granulo-membranous appearance (Pl. IV. 1). The ordinary structural elements of the mass have disappeared, and in their place yellowish, globular, oil-like bodies are found of various sizes, from a granule up to one-fourth the diameter of the cell, occupying a position within, and exterior to, the shrivelled primordial utricular mass (1, *e*).

No circulatory movement of the character of cyclosis is ever observed in the cell-contents, nor can any molecular movement be perceived. Upon the rupture of a cell, however, and the escape of its contents, the finer granules exhibit slight movements of the kind just mentioned (Pl. I. 1, *f*).

2. *Of the Secondary Cells.*—(Pl. I. 1, *e*; 4, *d*.) In the fully developed *Enterobryus* there are usually two secondary cells; but occasionally there is only one, and very rarely there are even three.

In *Enterobryus attenuatus*, I have never been able to detect two secondary cells, and only in a few instances have I seen one; arising probably from the more rapid separation of these cells, after their development, in this species than in the others (Pl. III. 15, 16). A rapid separation of the secondary cells would also account for the truncated appearance of the distal extremity of the principal cell, and the great thinness of the cell-wall forming the truncated face, which is often observed in *Enterobryus attenuatus*, and but rarely relatively in the other two species (17).

Ordinarily, where two secondary cells exist, as in *Enterobryus elegans* and *Enterobryus spiralis*, they are oblong tubular, and the penultimate cell is usually a little longer, narrower, and more cylindrical than the terminal cell.

The latter is more or less cylindro-clavate, obtusely rounded at the distal end, and curved.

The contents of the secondary cells are of the same character as those of the principal cell. They generally contain a very much greater proportion of the granular matter than the principal cell, and frequently may be observed to be filled with granules to the exclusion of globules, the reverse of which I have never seen (Pl. I. 1).

When a third secondary cell exists, which I have observed in two or three instances among some thousands of filaments of *Enterobryus elegans*, two are alike,

and correspond to the description of the penultimate secondary cell above given, while the third is like the ultimate one described. When a single secondary cell exists in the last-mentioned species of *Enterobryus*, it has usually the same appearance as the terminal cell of those cases in which two are found.

In a half dozen instances only, among several thousand filaments of *Enterobryus attenuatus*, have I been able to detect the existence of a secondary cell. In some cases it was relatively very short and cylindrical, a trifling degree narrower than the principal cell, truncated at its free extremity, concave at the other, and fitting upon the convex termination of the principal cell, and entirely filled with granular matter. In others, the secondary cell was a very little broader or more bulging than the principal cell, longer than in the former instances, obtusely rounded at the free extremity, and filled with a hyaline protoplasma, with a few granules.

The connection of the secondary cells with the principal cell and with one another is very variable in its appearance in Enterobryus, and indicates that the former are derived from the latter by a process of division; or, in other words, it indicates at least one of the modes of reproduction of the plant to be by division.

The first indication of the separation of a secondary cell from the principal cell is a faint line corresponding to a plane passing transversely through the contents of the latter in the vicinity of its distal extremity (Pl. IV. 25, *c*). Examples are met with in which such a plane exists with the merest trace of a circumferential contraction of the primordial utricle at the edge of the plane without the slightest mark of such a character existing in the permanent cell-wall. The cell-contents above the plane of separation and for some distance below are always more or less granular, frequently to the total exclusion of globules, although these are frequently met with within the fully formed secondary cells.

In well developed principal cells of *Enterobryus* without attached secondary cells, the free extremity very generally is more or less filled or even distended with the characteristic globules, and is clavate in form (Pl. III. 4, 14), but when secondary cells are observed in their commencement, they are filled with granular matter (Pl. IV. 18, 21, 24), from which it appears the globules within the distal extremity of the principal cell are converted into granules in the development of the secondary cells.

I never observed this transformation step by step, but only saw the conditions which I have just described. In these cases, if the globules are really converted into granules, it is most probably not by the former being broken up into corresponding masses of the latter, but by a separation of granules more or less rapidly from the circumference of the globules; for when secondary cells are in course of development from the principal cell, the distal extremity of the latter always contains more or less granular matter enveloping the globules, which are spherical, and, relatively to those ordinarily found lower down, small in size.

Following the plane of division of the principal cell-contents in the production of a secondary cell, examples of *Enterobryus* are met with in which the circumferential contraction before mentioned, existing at the edge of the plane in the

primordial utricle within the permanent cell-wall, is deeper than in the former cases.

Next succeeds a distinct separation of the material which is to constitute the contents of the new secondary cell from that of the principal cell, and a thin transparent partition is formed, between the two portions, continuous at its outer margin with the enveloping primordial utricle (23, *c*).

It is not until this period that examples of the plant are found in which there exists an evident constriction in the permanent cell-wall corresponding to the margin of the partition separating the secondary from the principal cell. This constriction deepens, and continues to advance concentrically until it completely divides the thin transparent partition formed from the primordial utrical and separating the two distinct masses of cell-contents (19), and thus we have formed from the principal cell a perfect new or secondary cell. In the case of *Enterobryus elegans*, upon which the above observations were made, the distal extremity of the principal cell, after the complete development of secondary cells still remaining in connection with the former, is obtusely rounded, a little broader than the secondary cells, and appears to indicate that these continue their attachment some time after they are fully formed.

From the truncated appearance of the principal cell being observed so frequently in *Enterobryus attenuatus*, I suspect that the secondary cells, after their production, detach themselves very rapidly, giving rise to the watch-crystal-like appearance of the free end of the cell, from the thinness of the new membrane continuous at its circumference with the older, thicker, and stronger permanent cell-wall (Pl. III. 17).

In *Enterobryus elegans* and *Enterobryus spiralis*, the production of one secondary cell is rapidly followed, or even accompanied by another, developed from the principal cell. In rare cases, even a third cell commences its development from the principal cell before the detachment of the terminal cell.

3. *Of the Pedicle and Mode of Attachment.* (Pl. II. 4, *c*; III. 6, 9, 11, *b*.) The pedicle of attachment of *Enterobryus* is more or less cylindrical, solid, hard, transparent, amorphous in structure, yellowish or brownish in color, and faintly striated longitudinally. Its length varies with the age of the plant, and, to some extent, with the position of attachment.

In the youngest plants it looks like a very slight conical or mound-like elevation or thickening of the basement-membrane of the mucous membrane from which the plant grows (Pl. II. 3, *b*). It is colorless, and, in these cases, from its amorphous appearance, appears to be part of the structure of the basement-membrane.

As the principal cell grows in length the pedicle does so also, and, in a little time, appears quite a distinct structure from the basement-membrane to which it is attached. It reaches its greatest degree of development in *Enterobryus elegans*, and when the latter is attached to the exterior of entozoa, it becomes much longer than in the plants growing from the mucous membrane of the intestine in which the entozoa are found (Pl. VI. 6, *e*; 7, *d*). Upon an *Ascaris infecta*, I have observed individuals of *Enterobryus* with the pedicle the $\frac{1}{200}$ of an inch in length, while, in those

plants growing from the mucous membrane of the intestine it usually does not grow more than the $\frac{1}{400}$ of an inch in length.

In *Enterobryus attenuatus*, the pedicle is usually relatively shorter and broader, and more conoidal than in *Enterobryus elegans*.

In the latter, with the growth in length of the pedicle, it becomes more or less transversely contorted.

At its basis of attachment, the pedicle, when fully formed, is expanded into a discoidal surface, by which it adheres with very great tenacity to its body of support, so as to permit rupture of the pedicle, or the principal cell, without detachment of the former.

In the very young thallus of *Enterobryus*, the principal cell is situated upon the convex summit of its pedicle, but as the former grows and the latter increases in length, the summit of the pedicle becomes depressed, and receives the convex commencement of the principal cell in the manner of a ball and socket joint.

The attachment of the principal cell to its pedicle is strong, and it is much easier to break than to detach them from one another.

In *Enterobryus attenuatus*, in two instances, I observed the pedicle, twice its usual size, divided at the summit, and giving connection to two primary cells of the plant (Pl. IV, 27, *b*). These cases, of course, constituted an abnormal conjunction, such as is frequently observed throughout the vegetable and animal kingdom.

4. *State of Development of Enterobryus in relation to its particular Locality of Growth.*—The most favorable position for the development of *Enterobryus* is the commencement of the small intestine, or, more properly, the ventriculus of *Julus*, and the transverse ridges bounding the sacculi of the ventriculus of *Passalus*. In *Julus*, in the position mentioned, *Enterobryus* may always be found, and, in most cases, with secondary cells in all stages of development. In *Julus marginatus*, lower down in the ventriculus, *Enterobryus* is frequently met with, but always small in size, and but very rarely advanced to such a degree as to produce secondary cells. Within the large intestine of the same species of *Julus*, it may often be observed, more especially at the lower part, in the most extraordinary profusion, but always in the earlier stages of growth, rarely more than the sixth of a line in length, and forming a single, simple curved cell with faintly granular contents, and occasionally a few small globules (Pl. II. 2).

Enterobryus elegans is frequently found attached to any part of the exterior of the body of the nematoid entozoa of *Julus marginatus*, even upon the spiculate tail of *Streptostomum* or *Thelastomum*, which has a very little larger diameter than the plant itself (Pl. VI. 1, 2, 4–7; VII. 12, 15). Upon these worms I have never detected *Enterobryus* advanced to the stage of development of secondary cells, and its greatest length upon *Ascaris infecta* I found reaching to one line, but never so much upon the more active *Streptostomum agile* and *Thelastomum attenuatum*.

I never detected *Enterobryus attenuatus* growing upon *Hystrignathus rigidus*, a nematoid entozoon rarely absent from the ventriculus of *Passalus cornutus*.

5. *Advantage of the peculiar forms of different species of Enterobryus.*—One of the most beautiful instances of means adapted to an end in view is presented in the

form of *Enterobryus.* The plant is fixed upon the mucous membrane of the intestinal canal, in which it grows, and from its delicate structure it must be more or less constantly liable to rupture in the peristaltic movements of the bowels, and the passage onwards of the food; but from the spiral arrangement of the thallus of *Enterobryus elegans* and *Enterobryus spiralis,* and the sigmoid flexure of that of *Enterobryus attenuatus,* the graceful filiform plants may be elongated or stretched onwards for a considerable distance without danger of being torn. (See Pl. I.)

6. *Reproduction of Enterobryus.*—It is no doubt the case that *Enterobryus* is not only reproduced by segmentation, but also by spores, although in several thousand individuals of *Enterobryus elegans* which I have examined, in over one hundred and fifty individuals of *Julus marginatus,* from early spring until late in the autumn, I am not positively certain that I either observed the formation of the spores, or the development of the plant from the spore.

The earliest condition in which I have been able to detect *Enterobryus elegans,* was in the form of a delicate, transparent, colorless, globular, oval, or ovate vesicle, measuring the $\frac{1}{2500}$ of an inch in diameter, or almost the $\frac{1}{1250}$ of an inch long, by the $\frac{1}{1888}$ of an inch broad (Pl. IV. 3). The contents consisted of a colorless protoplasm. When elongated, the poles of the parietes were thickened, and one end was adherent to the mucous membrane of the viscus in which these bodies were found.

In the next stage, the young *Enterobryus* had the form of a delicate, colorless, oblong, oval cell, the $\frac{1}{1000}$ of an inch long by the $\frac{1}{2300}$ of an inch broad, filled entirely with a faintly granular substance; or in other instances, with a mixture of this and globules, or with globules alone, attached by one extremity to a slight conoidal, pedicular elevation, arising from the surface of support (4–6). From this period, as it advances in its development, it is usually disposed to grow in a cylindroid, curved, clavate form, in which state it may be frequently met with from the size above given to the $\frac{1}{150}$ of an inch in length (8, 10). Having reached the latter point, it becomes more cylindrical, and up to the $\frac{1}{75}$ of an inch in length is disposed to grow into a single spiral coil (11).

Generally the cell-contents, from the earliest condition above mentioned, become almost wholly globular; but within the rectum of *Julus marginatus,* the contents of the plant-cells retain their granular appearance, occasionally with a very few globules, until the latest period in which I have observed them.

Occasionally, the young thallus of *Enterobryus elegans* grows to $\frac{1}{75}$ of an inch in length, perfectly straight, cylindro-clavate in form, and filled with globules (13, 14). Less frequently, it is found constricted somewhere near the middle of its length, the distal portion broader than the attached (15). More frequently than in the two last cases, it is found having a sort of geniculate bending at an obtuse angle in some part of its course, usually below the middle, but occasionally above it, with the distal portion possessing a greater diameter than the lower portion, which is straight, while the former is often curved, occasionally recurved, though sometimes also straight (17).

The young of *Enterobryus attenuatus* I observed growing within the ventriculus of the larva of *Passalus cornutus,* from the $\frac{1}{466}$ of an inch to the $\frac{1}{116}$ of an inch in

length, cylindrical, and straight or gently curved. Very frequently it presents a slight geniculate bend, occupying a position generally above the upper fourth or fifth of the thallus, the distal portion being straight or slightly curved, and, most commonly, narrower than the lower portion, the reverse of what is observed in the young of *Enterobryus elegans*. The contents usually consist of globules.

The next entophyte, to which I shall direct especial attention, I have named *Eccrina*, a genus closely allied to *Enterobryus*, to which, probably, most naturalists would refer it, but which I was led to consider as distinct, first, in the case of *Eccrina moniliformis*, which at the distal extremity of the thallus produces a very great number of globular secondary cells. The *Eccrina longa*, originally described as a species of *Enterobryus*,[1] from its also producing numerous secondary cells, though not globular, I afterwards preferred assigning to *Eccrina*.

§ 5. Description of the Genus and Species of Eccrina.

ECCRINA, Leidy.

Thallus attached, consisting of a single very long tubular cell, filled with granules and globules, producing at its free extremity a succession of numerous globular or oblong cells, and growing at the other end from a relatively short, cylindroid, amorphous, coriaceous pedicle, commencing with a discoidal surface of attachment.

1. Eccrina longa, Leidy.

Proc. Acad. Nat. Sci., v., 35.

(Plate V. Figs. 1–13.)

Thallus long, filiform, colorless, or brownish, transparent, cylindrical, usually not holding a constant relation of breadth to the length, forming a simple curve or single spiral turn, and then proceeding in a straight line or gently flexuose curve to the free extremity. *Pedicle* very short, columnar, expanded at the base. *Principal cell* very long, uniformly cylindrical. *Secondary cells* in various stages of development from ten to thirty in number, oblong, or short cylindrical, with obtusely rounded extremities when completed.

Whole length from 2 to 7 lines. Length of pedicle $\frac{1}{3000}$ to $\frac{1}{1500}$ of an inch. Breadth of principal cell, from $\frac{1}{2000}$ to the $\frac{1}{517}$ of an inch. Length of secondary cells, from the $\frac{1}{525}$ to the $\frac{1}{350}$ of an inch.

Habitation. Parasitic, growing in profusion from the mucous membrane of the posterior part of the intestinal canal of *Polydesmus virginiensis*.

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[1] Proc. Acad. Nat. Sci., vol. v., p. 9.

2. **Eccrina moniliformis**, Leidy.

Proc. Acad. Nat. Sci., v., 35.

Thallus colorless or ambreous, transparent, growing in a double or triple spiral. *Pedicle* short. *Principal cell* cylindrical. *Secondary cells* in various stages of development, from 20 to 50 in number, globular when fully formed.

Whole length, from 1 to 1½ lines. Breadth of principal cell $\frac{1}{1500}$ of an inch. Diameter of secondary cells, from the $\frac{1}{1875}$ to the $\frac{1}{1500}$ of an inch.

Habitation. Parasitic, growing from the mucous membrane of the intestinal canal of *Polydesmus granulatus.*

§ 6. History, Structure, etc. of Eccrina.

The genus *Eccrina* I have not had an opportunity of studying with as much care as *Enterobryus,* simply because the animals in which it is parasitic are not so abundant in the neighborhood of Philadelphia as the species of *Julus.* When I first discovered *Eccrina moniliformis,* I took notes of its appearance, but deferred figuring it until a more favorable opportunity, which, however, has not yet arrived; for I have since not been able to find any other than the young of *Polydesmus granulatus,* in which the entophyte, not constantly existing, does not present the fully developed condition.

To my friend, Professor Baird, then of Carlisle, Pennsylvania, now of the Smithsonian Institution, Washington, I am indebted for numerous individuals of *Polydesmus virginiensis,* from which I obtained materials for figures and full descriptions of *Eccrina longa.*

This species is remarkable on account of its very great relative length, not only to the other entophytes described, but also to the animal in which it is parasitic.

The principal cell in both species of *Eccrina* is almost uniformly cylindrical throughout, and in *Eccrina longa,* at its lower part, makes a long sigmoid flexure, or single spiral turn, as in *Enterobryus elegans,* while in *Eccrina moniliformis,* in union with its secondary cells, it usually makes a double or triple spiral, as in *Enterobryus spiralis.*

The breadth of *Eccrina longa* is not so uniform as that of *Eccrina moniliformis,* or the different species of *Enterobryus,* nor does it usually correspond to the length. Thus, I have observed filaments 4 lines in length, the $\frac{1}{1000}$ of an inch in diameter; filaments of 5 lines, the $\frac{1}{575}$ of an inch; a few of 3 lines, only the $\frac{1}{2500}$ of an inch, &c.

Eccrina is the most remarkable of the entophyta which I have discovered, because a full-grown individual exhibits at one view the process of multiplication of cells by division in the most gradual state of progression.

1. *Of the Principal and Secondary Cells.*—(Pl. V. 1–6.) The description of these two kinds of cells must be given together, as the contents in the distal extremity of the one pass gradually into the construction of the other.

The cell-contents consist of the same materials and in the same varying character as in *Enterobryus,* except in full-grown individuals, in which, at the distal extremity,

they are generally granular, often to the exclusion of globules, and are divided into distinct masses in the course of development into secondary cells.

In *Eccrina longa*, the secondary cells in their origin are first observable as relatively short cylindrical divisions of the cell-contents within the distal extremity of the principal cell (3). Their number does not always correspond with the length of the thallus. Thus, I have observed filaments 3½ lines long, with 25 secondary cells; others of 6 lines, with from 12 to 20; some of 7 lines, with from 16 to 30, etc. Nor is the length of the secondary cells uniform, nor in relation with that of the thallus (1–4). They vary in the same and in different individuals in this respect. In some individuals they are found increasing in length successively from the first to the last, indicating a continuance of growth during the process of development by division from the primary cell. Thus, in an individual of 6 lines in length, with 24 secondary cells, the first measured the $\frac{1}{600}$ of an inch in length, by the $\frac{1}{855}$ of an inch in breadth, and the others very gradually increased in length, but diminished slightly in breadth to the last, which measured $\frac{1}{350}$ of an inch in length by the $\frac{1}{1111}$ of an inch in breadth. In another individual, 5 lines in length with 12 secondary cells, these were nearly uniform, measuring from $\frac{1}{250}$ to $\frac{1}{300}$ of an inch in length by $\frac{1}{750}$ of an inch in breadth. In another, of 4½ lines with 16 cells, they all measured $\frac{1}{185}$ of an inch in length by $\frac{1}{880}$ of an inch in diameter. In another, of 7 lines with 25 secondary cells, the first measured $\frac{1}{300}$ of an inch in length, the fourth only $\frac{1}{535}$ of an inch, and the last $\frac{1}{375}$ of an inch.

The contents of the secondary cells, from their earliest condition, are uniformly granular (1, *c*; 2, *b*; 3, *b*; 4, *a*), and in mass appear white and opaque. The granules are distinct, spherical, transparent, and colorless, and measure from $\frac{1}{15000}$ to $\frac{1}{7500}$ of an inch in diameter. I never observed globules within the attached secondary cells, but have seen them within those which have become detached, which will be again referred to (6, *a*).

The contents of the primary and secondary cells and the cell-wall, conduct themselves, upon the application of chemical reagents, in the same manner as *Enterobryus*.

In the progressive formation of secondary cells, the first step is the division of the contents within the distal extremity of the primary cell into separate cylindrical masses.

At the circumference of the planes of division, a constriction of the primordial utricle is very early observable, and sometimes a constriction of the permanent cell-wall rapidly follows or is almost coexistent, but frequently it does not form until a late period, as in *Enterobryus elegans*.

Upon the segmentation of the contents within the distal extremity of the primary cell in the formation of secondary cells, the inner surface of the permanent cell-wall appears to become combined or continuous with an extremely thin and delicate membranous layer occupying the planes of separation of the cylindrical, granular cell-masses, which I suspect is derived from the primordial utricle, or preferably from the coagulation of a portion of protoplasma, which has exosmosed from the interior of the cell-masses, each inclosed within a distinct sac of the primordial utricle, into the interspace at their extremities. This, I say, I suspect to be the mode of origin of the partition continuous with the permanent cell-wall between

the secondary cells; for when the cell-masses, at an early period of their division, are made to shrink from one another by the application of acetic acid, an exceedingly delicate, but entire membranous partition is observable, or none at all; and in no instance could I detect a concentric growth from the inner surface of the permanent cell-wall ultimately intended to separate the cell-masses. After the formation of the membranous partition described, the permanent cell-wall at the boundary of the former becomes constricted, and the secondary cells are apparently completed by a splitting of the membranous partition through the advancing constriction of the permanent cell-wall.

Before complete division of the secondary cells, the permanent cell-wall at the margin of its constriction above and below, is somewhat thickened (2 *c*), but afterwards again assumes the general thickness, and the two portions of the divided partition between the secondary cells are thickened to the extent of the lateral portion of the cell-wall. Frequently, the secondary cells become detached before the cell-wall at the end has become as thick as it exists laterally, and in such cases the circumference of the extremity is indicated by a thickened annulus of the cell-membrane, while that portion of the latter included within the area of the annulus, resembles the crystal upon the face of a watch (4, *a*); an appearance, as before stated, frequently observed at the free extremity of the primary cell of *Enterobryus attenuatus*, and of *Enterobryus elegans*.

The course of development of the secondary cells of *Eccrina moniliformis* is the same exactly as that of *Eccrina longa*. It is, however, more striking, from the extraordinary number of cells involved in the process, which exhibit a very gradual progression from the earliest stage to the fully-developed cells. In this species the early divisions of the cell-contents within the distal extremity of the primary cell are transversely oblong, but soon assume the globular form as they successively approach the free end of the thallus.

The secondary cells of *Eccrina*, in all their stages, uniformly possess granular contents.

2. *Of the Pedicle of Eccrina.*—This has the same structure and mode of attachment as in *Enterobryus*, but it is always relatively very short.

3. *Of the Position of Growth.*—I have found *Eccrina* growing only from the mucous membrane of the ventriculus of *Polydesmus virginiensis* and *Polydesmus granulatus*, especially at its commencement, in which position it reaches its most perfect development. I never detected *Eccrina longa* growing upon *Thelastomum labiatum*, an entozoon of *Polydesmus virginiensis.*

4. *Of the Development.*—As in the case of *Enterobryus*, I have never been able to observe the process from the spore, but have traced it from a very early condition, most probably derived from the latter, and also from the secondary cells detached from the parent plant.

Detached secondary cells of *Eccrina longa*, are not unfrequently observed intermingled with the growing filaments of the mother plants. The form of these detached cells is like those at the free end of the row of secondary cells still attached but ripe for separation, that is, oblong, or short cylindrical, with obtusely rounded extremities. They are filled with uniform granular contents, as in the attached

cells, or they are found filled with a fainter granular matter and more protoplasm, apparently as if much of the original granular matter had undergone solution, and less frequently some are observed containing granular contents mixed with globules.

The secondary cells do not always become detached singly from the parent plant, for I have occasionally observed two and three clinging together by their extremities, but separated from the parent (6).

The detached cells exhibit a remarkable disposition to reattach themselves by one extremity, usually to the mucous membrane of the intestinal canal; but, in several instances, I have observed them attached to the sides of a growing thallus (5 *c*). The law which determines the detachment of the secondary cells from the parent plant, to become again attached to some other body is curious and difficult to understand.

Besides detached secondary cells, more frequently young growing thalli of *Eccrina* are observed, remarkable for their singular form. These consist of a primary cell from the $\frac{1}{500}$ of an inch to the $\frac{1}{4}$ of a line in length, with an abrupt geniculate bend in some part of its course, the upper and lower portions forming a more or less obtuse angle with each other (8, 9, 11, 13). The portion below the flexure is cylindrical and usually straight, but occasionally is slightly curved, or sigmoid, and measures from $\frac{1}{5000}$ to $\frac{1}{1500}$ of an inch in diameter. The upper or distal portion is more or less dilated, cylindroid, straight, obtusely round at the end, and measures from the $\frac{1}{3000}$ to the $\frac{1}{750}$ of an inch in diameter.

The bend or flexure occurs at any point below the distal third of the thallus. Sometimes the lower portion of the latter is twice as long as the upper, when it looks like an oblong cell supported upon a long footstalk (13); in other cases, the upper portion is four or five times longer than the lower (12).

Occasionally, the young thallus observes a straight course throughout, and is clavate in form (10).

The contents of the young filaments of *Eccrina* consist of protoplasma with faintly granular matter (12), or the same combined with a few globules (10), or the lower portion of the cell is filled with the former, and the upper portion with the latter (8, 11); or, in rather older individuals, the upper portion is frequently distended with globules, while the lower contains a mixture of granules and globules passing gradually into a mass of protoplasma at the lower extremity (13), or the whole, in still more advanced individuals, is entirely filled with globules with a very few granules and a small quantity of intervening protoplasma (7).

The attachment of the young of *Eccrina*, like that of *Enterobryus*, is upon a slight conical elevation, apparently part of the structure of the basement-membrane.

§ 7. Description of the Genus and Species of Arthromitus.

ARTHROMITUS, Leidy.

Proc. Acad. Nat. Sci., iv., 227.

Thallus attached by means of one or more granules, simple, cylindrical, very long, filamentous, articulate, without ramuli. *Articuli* indistinct, with amorphous contents finally converted into solitary oval sporuli.

1. Arthromitus cristatus, Leidy.

Proc. Acad. Nat. Sci., iv., 227.

Arthromitus nitidus, Leidy: ibid., v., 35.

(Plate II., Fig. 1, *i;* V. 3, *d*, 14, 15; VI. 5 *e;* VIII. 1 *f*, 2 *d*, 3, 4, 5.)

Thallus very delicate, filamentous, linear, straight or inflected, flexible, colorless, translucent, obtusely rounded at the free end. *Pedicle* of attachment one or more amber-colored round or oval granules. *Articuli* indistinct, but becoming well-marked after the development of the interior sporular body. *Spore* oval, simple, faintly yellowish, translucent, highly refractive, usually lying oblique and alternating in position in different articuli. Length from the $\frac{1}{1500}$ to the $\frac{1}{12}$ of an inch. Breadth about the $\frac{1}{16250}$ of an inch.

Habitation. Parasitic, grows from the mucous membrane of the ventriculus and large intestine of *Julus marginatus*, and also upon *Enterobryus elegans*, *Ascaris infecta*, *Streptostomum agile*, and *Thelastomum attenuatum;* from the mucous membrane and its appendages of the ventriculus of *Passalus cornutus*, and *Polydesmus virginiensis*, and upon *Eccrina longa.*

§ 8. History, Structure, etc. of Arthromitus.

The genus *Arthromitus*, I first detected growing within the ventriculus of *Julus marginatus.* Some time subsequently, I detected much larger filaments of the same plant, with relatively very distinct articuli, growing within the large intestine of the same animal, which I supposed to be a distinct species from the former, and, therefore, described it as such under the name of *Arthromitus nitidus.* Since then, within *Julus marginatus*, *Passalus cornutus*, and *Polydesmus virginiensis*, I have observed *Arthromitus* under a variety of conditions, and in all gradations of size and development, from the simple, exceedingly minute, inarticulate filament, to a length of one line, with distinct articuli; and therefore I cannot, at present, distinguish more than one species; and for this, the name is retained which was first proposed.

As just stated, I have observed this entophyte from the condition of an exceedingly minute, delicate, inarticulate filament to a thallus one line long, and distinctly articulate, and containing within very many of the articuli, sporular bodies.

Frequently, there may be detected, growing with the undoubted thallus of *Arthromitus*, filaments of the former character; simple, hyaline, and inarticulate, as short as the $\frac{1}{3000}$ of an inch, as long as the $\frac{1}{50}$ of an inch, and not more than the $\frac{1}{33000}$ of an inch in diameter. With these are intermingled filaments, very faintly articulated, measuring up to the $\frac{1}{12500}$ of an inch in diameter.

Within the ventriculus of *Julus marginatus*, this entophyte, when fully developed, measures from the $\frac{1}{500}$ to the $\frac{1}{300}$ of an inch in length, by the $\frac{1}{20000}$ to the $\frac{1}{12500}$ of an inch in diameter.

Within the large intestine of the same animal, *Arthromitus* appears to reach its

greatest degree of perfection, attaining dimensions of one line in length by the $\frac{1}{5200}$ of an inch in breadth, with remarkably distinct articuli (Pl. V. 14, 15).

Within the ventriculus of *Passalus cornutus*, filaments of the plant often acquire a length of $\frac{1}{4}$ of a line, and occasionally even of a $\frac{1}{2}$ line, with a diameter of the $\frac{1}{11000}$ of an inch.

The articuli of *Arthromitus*, excepting when they contain spores, are usually indistinct, arising apparently from the general amorphous character of the contents which have the same or very nearly the same refrangibility as the cell-wall. Their average dimensions are the $\frac{1}{10000}$ of an inch in length by the $\frac{1}{16250}$ of an inch in breadth. In the variety which grows within the large intestine of *Julus marginatus*, the articuli are about the length of the diameter of the filaments, or a very little longer. In that of *Passalus cornutus*, they average the $\frac{1}{12500}$ of an inch in length.

The filaments of *Arthromitus* are cylindrical, and only depart from this general form in the very slight dilatation which often exists in the articuli, giving them a keg-shaped appearance. The contents of the thallus are always amorphous and hyaline, never having even the faintest appearance of granules.

Not unfrequently, in the largest variety of *Arthromitus*, several articuli along the course of the thallus are contracted into a solid columnar form, not more than half the diameter of the others (14, *c*).

1. *Of the Spores of Arthromitus.*—These are always observed single within the articuli. Most frequently, they exist only in the articuli which form the distal portion of the thallus, but they are also often seen in any part of the length of the latter, sometimes at intervals of a variable number of articuli containing none; and occasionally, they exist in all the articuli.

In the largest variety of *Arthromitus*, in which the character of the sporuli is best observed, the articulations which contain them are slightly contracted, or have a little less diameter than the others (15, *b*).

The position of the sporuli is usually oblique, and they alternate in this direction in the different articuli; frequently, they are arranged longitudinally, never transversely. They are elliptical in form, transparent, highly refracting like oil-globules, of a light amber-color, and are amorphous in structure. On the average, they measure the $\frac{1}{12000}$ of an inch in length, by the $\frac{1}{22000}$ of an inch in breadth. In the *Arthromitus* of *Passalus cornutus*, they measure the $\frac{1}{10000}$ of an inch in length, by the $\frac{1}{25000}$ of an inch in breadth. In the largest variety of the plant, they measure the $\frac{1}{7000}$ of an inch in length, by the $\frac{1}{12500}$ of an inch in breadth.

2. *Of the Development of the Spores.*—This is most readily observed within the articuli of the largest variety of *Arthromitus* growing within the large intestine of *Julus marginatus* (14, 15). The sporuli appear to originate in a gradual contraction, condensation, and consolidation of the protoplasmoid contents of the articulations. Within these, may frequently be observed single oval or clavate, or bent oval or reniform masses, faintly outlined, and nearly filling their cavity (15, *a*). The masses gradually contract to the bulk of the spores, and become distinct, shining, and highly refracting, and in this condition constitute the fully-developed sporuli (*b*).

3. *Of the Mode of Attachment of the Thallus.*—Although the attachment of *Arthromitus* is very firm and tenacious, yet the thallus possesses no pedicle like that of *Enterobryus* and *Eccrina*, but grows from granular bodies resembling those upon which the algoid filaments of the human teeth, and those of other animals, are based.

The granules of attachment, from which a few filaments start, are often single or isolated; but usually there is an aggregation of several granules, from which grow more or less dense bunches of the plant (3, *e*; 14, *a*; VIII. 5). The granules adhere to their basis of attachment as if cemented. They measure from the $\frac{1}{20000}$ to the $\frac{1}{16000}$ of an inch in diameter; usually appear globular in form, and are amorphous and amber-colored, and refract light as highly as oil-globules.

4. *Of the Particular Locality and Mode of Growth.*—*Arthromitus* may be found in at least 90 per cent. of cases, within the ventriculus of *Julus marginatus*, ranging from single isolated filaments to very dense bunches. It grows, in company with *Enterobyrus elegans*, from the mucous membrane, especially near the commencement of the organ. When in bunches, or tufts, the filaments spread or radiate from their central granules of attachment, like a dense tassel held upwards. Occasionally, the bunches are found closely twisted, with their filaments intertwined and plaited, forming columns, from the $\frac{1}{3000}$ to the $\frac{1}{1250}$ of an inch in diameter, spreading at the summit.

Arthromitus is frequently found growing upon *Ascaris infecta*, *Streptostomum agile*, and *Thelastomum attenuatum*, upon any part of the exterior surface, but most usually from the lips of the anal and generative apertures, or the interspaces of the annuli of the body; these, apparently, being the most favorable resting-places for the sporuli from which the filaments are developed.

It is also frequently found growing in great profusion upon *Enterobryus elegans*, often in dense bunches, covering its summit (Pl. III. 12), or in a number of concentric circles on any part of its length, or radiating from particular points (Pl. VI. 1, *h*). A favorite locality for its growth, upon this species of *Enterobryus*, is the basis of attachment of the pedicle of the latter, or the junction of this with the primary cell. The youngest individuals of *Enterobryus* are sometimes so completely covered with *Arthromitus* as to be entirely obscured or hidden from view (Pl. IV. 16, *c*).

As before mentioned, *Arthromitus* reaches its highest degree of development in the large intestine of *Julus marginatus;* a curious fact, when we recollect that *Enterobryus elegans,* although growing here in greater profusion than in the ventriculus, never advances to the formation of secondary cells. In the same relation to quantity as we find *Enterobryus*, with its state of development in the two cavities mentioned, so we also find that *Arthromitus*, with its greater degree of perfection in the large intestine, does not grow in dense bunches, as in the ventriculus, but in a very small number of filaments associated together, frequently in pairs; two, four, or eight, often single, very rarely more than eight together.

I have never observed *Arthromitus* to be parasitic upon the entozoa or *Enterobryus*, within the large intestine of *Julus marginatus*. *Arthromitus* is found within the ventriculus of *Polydesmus virginiensis*, but not in the profusion in which it occurs in

Julus marginatus. It is also not unfrequently found parasitic upon *Eccrina longa,* growing in the same manner as upon *Enterobryus elegans.*

Within the ventriculus of *Passalus cornutus,* it grows from any part of the surface, not so abundantly as in *Julus marginatus;* but, nevertheless, profusely from the hair-like appendages of the cavity, or from the mucous membrane forming the doublings separating the sacculi of the stomach.

I never observed it parasitic upon *Enterobryus attenuatus.*

§ 9. Description of the Genus and Species of Cladophytum.

CLADOPHYTUM, Leidy.

Thallus attached by means of one or more granules; filamentous, simple, with minute lateral ramuli, or branched, inarticulate, amorphous in structure.

1. Cladophytum comatum, Leidy.

Proc. Acad. Nat. Sci., Phila., iv., 227.

Cladophytum ramosissimum, Leidy: Ibid., iv., 250.

(Plate II. Fig. 1 *h;* Pl. IV. Figs. 27 *d,* 28 *f;* Pl. V. Figs. 3 *f,* 14 *e;* Pl. VI. Fig 7 *f;* Pl. VIII. Figs. 1 *d,* 2 *c,* 6, 7, 8.)

Thallus very delicate, linear, colorless, simple, with very minute ramuli, or very much branched, with minute ramuli upon the terminal branches. *Pedicle* of attachment one or more, amber-colored, spherical, amorphous granules. Length from the $\frac{1}{800}$ to the $\frac{1}{75}$ of an inch.

Habitation.—Parasitic, in the same positions with *Arthromitus.*

§ 10. History, Structure, etc. of Cladophytum.

In the preceding description, I have included what I formerly considered to be two distinct species of *Cladophytum,* as I have since observed a variety of intermediate forms which indicate them to be the same.

Cladophytum is the most minute of the entophyta which I have distinctly observed. It is very heteromorphous in its character, and there may probably be several species; but the power of the microscope in its present condition is not sufficient to characterize them.

It always appears colorless, branching, and entirely amorphous in structure.

Frequently, it is found consisting of simple filaments, with minute simple ramuli from the $\frac{1}{700}$ to the $\frac{1}{100}$ of an inch in length, by the $\frac{1}{30000}$ to the $\frac{1}{25000}$ of an inch in diameter, growing in more or less dense bunches or tufts (Pl. VIII. 6). The ramuli do not measure more than the $\frac{1}{8000}$ to the $\frac{1}{7000}$ of an inch in length. It is also commonly observed, more or less branching, from the $\frac{1}{800}$ to the $\frac{1}{75}$ of an inch in length (Pl. V. 3, *f;* 14, *e*). The branches are about the $\frac{1}{15000}$ of an inch in

diameter, and are provided with very minute, oblique ramuli, about the $\frac{1}{3000}$ of an inch in length (Pl. VIII. 7).

The thallus of *Cladophytum*, even at the conjunction of the branches, never presents the slightest trace of articulation.

Of the development of this plant, or the formation of its spores, I could detect nothing.

Its mode of attachment is the same as that of *Arthromitus*.

The granules of attachment measure from the $\frac{1}{7500}$ to the $\frac{1}{2500}$ of an inch, and often exist in masses the $\frac{1}{600}$ of an inch in diameter.

Cladophytum grows in all the positions in which *Arthromitus* is found, and the smallest variety of the former is sometimes observed even growing upon the largest variety of the latter. It is found in the most extraordinary profusion within the ventriculus of *Passalus cornutus*, attached to the mucous membrane and its hair-like appendages, (Pl. VIII. 1; IX.)

§ 11. Description of the Genus and Species of Corynocladus.

CORYNOCLADUS, Leidy.

Thallus attached by means of one or more granules; filamentous, very compound; branches thicker than the trunk, without ramuli; inarticulate, amorphous in structure.

Corynocladus radiatus, Leidy.

Proc. Acad. Nat. Sci., Phila., iv., 250.

(Plate VIII. Fig. 1 *e*; IX. Fig. 2 *e*; X. Figs. 1, 2.)

Thallus solitary, or growing in more or less dense bunches. Trunk or main stem relatively narrow, variable in length, either dividing shortly after its origin into several principal branches, which subdivide into numerous others, many times longer and thicker than the trunk, and cylindro-clavate in form, and obtusely rounded at the extremities, or gradually subdividing into numerous cylindro-clavate branches, thicker but not longer than the trunk.

Maximum length the $\frac{1}{60}$ of an inch. Breadth of trunk from the $\frac{1}{15000}$ to the $\frac{1}{12500}$ of an inch in diameter. Branches $\frac{1}{600}$ to the $\frac{1}{140}$ of an inch in length, by the $\frac{1}{7000}$ to the $\frac{1}{6000}$ of an inch in breadth.

Habitation.—Parasitic, observed only growing from the mucous membrane and its appendages of the ventriculus of *Passalus cornutus*.

§ 12. History of Corynocladus.

I have never observed the development of this entophyte, nor anything certain in regard to the formation of its spores, although I have noticed a frequent appearance of a faint granular substance adhering to the exterior of the clavate branches, which, under a power of 600 diameters, is indistinctly resolved into the form of elliptical masses, resembling sporules (Pl. X. 2).

§ 13. On some Parasitic Phytoid Bodies, the nature of which is obscure.

Among the objects which I detected with a good deal of constancy within the ventriculus of *Passalus cornutus*, is one which has puzzled me exceedingly. It is an elongated tubular cellule, attenuated at both ends, which I formerly described, probably too hastily, as an entophyte, under the name of *Cryptodesma*.[1] Up to the present time, I have not been able to satisfy myself of its true character; whether it be really an entophyte, or only the epithelial cells of the ventriculus, elongated by endosmosis (Pl. X. 3). One would suppose it to be an easy matter to resolve this question, but there are many difficulties in the way of its determination. Its constancy of existence is no objection to its entophytic character, for certain undoubted entophytes, as *Enterobryus attenuatus*, *Arthromitus*, and *Cladophytum*, and an entozoon, *Hystrignathus rigidus*, are quite as constant in their existence.

The epithelial cells of the mucous membrane are ordinarily in the form of columnar prisms. The bases of attachment of these I have often very distinctly observed through the translucent basement-membrane from the exterior; but their sides, even at the edge of a section of the mucous membrane, I could never satisfactorily examine, on account of their being totally obscured by the vast profusion of *Arthromitus*, *Cladophytum*, and *Corynocladus;* more particularly, however, by a peculiar vegeto-granular substance, growing everywhere from the surface of the membrane. In the larva of *Passalus*, these cells can readily be distinguished, and in this they are observed to be prismoid, and are not altered by the endosmosis of water, so as to assume the form of the phytoid cells in question. These latter were always seen detached, usually in groups, or adhering to masses of granular matter, but were never observed attached to the hair-like appendages of the mucous membrane.

In structure, they resemble more the cellules of a fungous mycelium, than the algoid plants previously described, consisting of a delicate tubular cell, usually somewhat irregular, and inclosing very finely granular contents. Acetic acid does not dissolve them, nor does it destroy the appearance of epithelia observed through the basement-membrane.

I have examined numerous individuals of *Passalus*, to ascertain the true nature of the bodies described, and sometimes almost concluded they were entophytic parasites; at others, that they were really elongated epithelial cells; and, for the present, I leave the subject, with the intention of investigating it more closely and patiently at a future time.

In addition to the entophyta described in the preceding pages, which inhabit the alimentary canal of *Julus marginatus* and *Passalus cornutus*, there is also found within the ventriculus of these animals a peculiar phytoid substance, which is worthy of attention.

The surface of the mucous membrane of the ventriculus of *Julus marginatus*, is

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[1] Proc. Acad. Nat. Sci., Phila., iv., 250.

very generally studded, at irregular intervals, with circular or oval plano-convex patches, from the $\frac{1}{3000}$ to the $\frac{1}{214}$ of an inch in diameter, and the $\frac{1}{7500}$ to the $\frac{1}{1425}$ of an inch in thickness, composed of an exceedingly fine granular substance, yellowish or brownish in color (Pl. VIII. 2, *a*). When the patches are larger, they are more or less lobulated at the circumference, and have the appearance of being composed of several smaller ones which have run together.

These patches do not originate in a mere deposit of particles of food upon the mucous membrane; and though not composed of organic cells, or their transformations, but only of the minutest granules, measuring from the $\frac{1}{50000}$, or even less, to the $\frac{1}{20000}$ of an inch in diameter, yet their character is phytoid. Truly parasitic, they firmly adhere to the mucous membrane, and increase in breadth by growth at the edges. The latter, from their thinness, give the appearance to the patches as if they possessed a distinct translucent border.

Sometimes the patches have a faintly radiated appearance, which is especially distinct at the translucent margin.

Besides these patches, there not unfrequently exist irregularly oval or ovate bodies attached to the mucous membrane, amorphous in structural appearance, translucent, of a deep-amber color, and measuring from the $\frac{1}{1500}$ to the $\frac{1}{375}$ of an inch long, by the $\frac{1}{3000}$ to the $\frac{1}{425}$ of an inch in breadth (*b*). These bodies often become the nucleus of growth of the granulo-phytoid patches, and either or both form a favorable nidus of attachment to *Arthromitus* and *Cladophytum*. None are ever observed growing upon the exterior of the nematoid entozoa, infesting the ventriculus of *Julus marginatus*.

Within the ventriculus of *Passalus cornutus*, the hair-like appendages, which everywhere cover the surface of the mucous membrane, are constantly more or less enveloped in a granulo-filamentous phytoid substance. As in the case of the phytoid patches of the ventriculus of *Julus marginatus*, this substance is not a mere deposit of particles of food, but a regular parasitic growth (Pl. VIII. 1, *c*; IX. 2, *c*). Upon the long hairs (Pl. VIII. 1, *b*), which fringe the transverse folds between the ventricular sacculi, this matter accumulates to the thickness of from the $\frac{1}{3000}$ to the $\frac{1}{425}$ of an inch. When a mass is compressed, it has a faintly radiated appearance from the centrally inclosed hair.

The color of this peculiar phytoid substance is ochreous yellow, passing into brownish at the surface of the masses (Pl. IX. 2, *c*).

Frequently, it is observed accumulated upon the summit, or upon any part of the length of the hairs (Pl. IX. 2), into round or oval masses, of a yellowish-brown, brown, reddish-brown, or light-yellow color, with a more or less thick external stratum, of a faint-yellowish hue, and radiate appearance.

From the granulo-filamentous phytoid substance a vast profusion of *Arthromitus*, *Cladophytum*, and *Corynocladus* grow, radiating from the surface of some masses in every direction, from the summit alone of others, or hanging in festoons, the whole together presenting a most wonderful appearance, and needing no stretch of the imagination to perceive the resemblance to a most intricate forest, heightened to a very great extent by the natural anatomical arrangement of the ventriculus (Pl. IX. 1).

CHAPTER II.

A FAUNA WITHIN ANIMALS; BEING DESCRIPTIONS OF NEMATOID ENTOZOA FOUND ASSOCIATED WITH ENTOPHYTA, AND OF OTHERS ALLIED TO THEM.

Associated with the extraordinary flora of the intestinal canal of *Julus marginatus* and *Passalus cornutus*, there is also a rich fauna. Within the former animal, there exist, with a good deal of constancy, the following entozoa:—

1, *Gregarina Juli marginati,*[1] within the proventriculus; 2, *Ascaris infecta;* 3, *Streptostomum agile;* 4, *Thelastomum attenuatum;* 5, *Nyctotherus velox;*[2] 6, *Bodo julidis;*[3] and 7, a species of *Vibrio*, within the ventriculus and large intestine.

In *Passalus cornutus* are found:—

1, *Gregarina Passali cornuti,*[4] within the proventriculus; 2, *Hystrignathus rigidus*, within the ventriculus.

External to the intestinal canal, and within the abdominal cavity, there is likewise found an enormous quantity of a species of nematoid worm, apparently not fully developed,[5] and in the thoracic cavity a second species is occasionally observed.[6]

The only helminth observed in the intestinal canal of *Julus pusillus* was a species of *Gregarina.*[7]

The common cockroach, *Blatta orientalis*, contains within its intestinal canal several species of animals, frequently in great numbers, and also, according to Valentin,[8] an entophyte which grows from the mucous membrane of the large intestine. The same plant, Valentin states, grows within the rectum of *Astacus fluviatilis*. He refers it to the genus *Hygrocrocis*, under the specific name of *H. intestinalis*, and thus characterizes it: "*Fila simplicia, tenuissima, prolonga, articulata, serpentina, apice recta, moniliformia, articulis globosis.*"

A plant agreeing with this description I have not been able to find in the same insect, the cockroach, introduced into this country; but, instead of it, in the same situation mixed with the contents of the intestine, or growing from its mucous membrane, or occasionally from the nematoidea infesting the cavity, simple, inarticulate, amorphous filaments from the $\frac{1}{25000}$ to the $\frac{1}{20000}$ of an inch in diameter (Pl. VII. 7, *e*).

The entozoa of *Blatta orientalis* are: 1, *Vibrio;* 2, *Bodo;* 3, *Nyctotherus ovalis;*[9] 4, *Gregarina;*[10] 5, *Streptostomum gracile;* and 6, *Thelastomum appendiculatum.*

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[1] Trans. Am. Phil. Soc., x. 237. [2] Ib. x. 244. [3] Ib. [4] Ib. x. 238. [5] Ib. x. 241. [6] Ib. 243. [7] Ib. 238.
[8] *Repert. für Anat. und Phys.*, Band I, S. 110, 1836. Robin: *Des Végét. qui crois. sur L'Homme*, etc., p. 82, 1847. [9] Trans. Am. Phil. Soc., x. 244. [10] Ib. x. 239.

§ 1. Description of a Species of Ascaris.

1. **Ascaris infecta**, Leidy.

Proc. Acad. Nat. Sci., Phila., iv., 229.

(Plate VI. Figs. 1, 2, 6, 7; VII. Figs. 5, 11, 14, 16–20, 22.)

Body nearly cylindrical, attenuated posteriorly, obtusely rounded anteriorly, white, translucent, with the brownish intestine faintly visible through the integument; tail long, conoidal, curved, acute; lobes of the mouth prominent. Buccal organ (œsophagus) robust pyriform, or oblong and dilated below; gizzard short, cordiform; intestine cylindroid, narrowing posteriorly, slightly dilated at commencement; rectum elongated, obpyriform, oblique.

Male relatively more cylindrical, with the posterior extremity incurved (Pl. VII. 5, *a*); furnished ventrally upon each side anterior to the anus, with a longitudinal row of four minute conoidal tubercles connected by delicate folds of integument; tail relatively thicker and shorter, furnished upon its ventral surface with two minute conoidal tubercles. Penis composed of two equal acinaciform spiculæ, about $\frac{1}{6}$ of a line long.

Length 2 lines; breadth at origin of intestine $\frac{1}{175}$ of an inch; at middle $\frac{1}{210}$ of an inch; just anterior to anus $\frac{1}{200}$ of an inch. Length of tail from anus $\frac{1}{175}$ of an inch.

Female, straight (Pl. VII. 5, *b*). Generative aperture just posterior to the middle, prominent. Vagina furnished with a large oblong ovate spermatheca.

Length of adult 3 to $4\frac{1}{2}$ lines; breadth anteriorly $\frac{1}{120}$ of an inch; at middle $\frac{1}{85}$ to $\frac{1}{60}$ of an inch; posteriorly $\frac{1}{140}$ of an inch.

Ova oval, $\frac{1}{319}$ inch long, by $\frac{1}{428}$ inch broad.

Especial Habitation.—Found constantly within the ventriculus of *Julus marginatus*, occasionally within the large intestine. It is sometimes very numerous, of various ages and sizes. The males are found in proportion to the females about as one to eight.

§ 2. Habits and Anatomy of Ascaris Infecta.

This *Ascaris* is frequently observed clinging by means of the mouth to the epithelial lining of the ventriculus of *Julus* (Pl. VII. 5).

In copulating, the male hangs in a sigmoid curve backwards from the female, the spiculæ of the penis introduced within the vagina of the latter (11).

Anatomy.—The buccal organ is very broad and strongly muscular. Its length is about the $\frac{1}{80}$ of an inch in the female and about two-fifths less in the male (Pl. VI. 1, *a;* 2, *b*).

The gizzard is strongly muscular, and nearly as broad as it is long (1, *b;* 2, *c*).

The intestine is cylindroid, but narrows very gradually from its slightly dilated origin to its termination (1, *c*). Its central position within the cavity of the body is maintained by means of very delicate filaments which pass from the exterior surface of the organ to the interior surface of the visceral cavity (6, 7).

The mucous membrane of the intestine is lined with an epithelium composed of distinct, hexahedral, granular, nucleated, organic cells (1, 2, 6, 7).

The rectum is inverted pyriform, with an elongated narrow neck, passing in an oblique or slightly curved direction to the anal aperture. It is thinner than the intestine, and the epithelial cells of its mucous membrane are not so distinctly visible (6, *b*; 7, *b*).

To the neck of the rectum and the inner margin of the anal aperture are connected a number of muscular bands, radiating in a convergent manner from the posterior surface of the visceral cavity.

The generative apparatus (VII. 14), in the female, consists of two long ovarial tubes, one placed anterior and the other posterior to the position of the generative aperture. Each tube commences by a cœcal extremity, is irregularly cylindrical, dilatable, tortuous, and performs two small convolutions in its course, and is doubled one and a half times upon itself and the intestinal canal. Each may be considered to consist of two portions; the ovary continuous with the oviduct.

The ovary (14, *a*) dilates very gradually, from its commencement for two-thirds of its course, after which it is usually more or less irregular in its capacity, depending upon the quantity of contents; but near its termination in the oviduct, it is usually more or less abruptly narrowed and transversely contorted.

The ova within the ovary, for one-third its length, line the interior surface, in the form of nucleolated, nucleated, organic cells, polyhedral from mutual pressure. Advancing towards the oviduct, these cells gradually become larger until they arrive at the lower half of the ovary, where they are so large as to fill the caliber of the latter in a single row, and the mass of granular contents increases to such an extent that the original nucleus or the germinal vesicle of the egg is completely obscured. The ova in the lower half of the ovary are so compressible and elastic as to assume any form which may arise from exterior pressure; usually, this form is some modification of the oval.

The lower extremity of the ovary is lined with an epithelium, though indistinct and apparently not concerned in the genesis of ova.

The oviduct commences as an abrupt spheroid or pyriform dilatation (*b*), and rapidly narrows into a cylindroid tube or neck, which performs a single short convolution, and then passes into a straight very dilatable portion to join its fellow of the other extremity of the body.

The oviduct is lined from its pyriform commencement with a distinct epithelium, composed of polyhedral nucleated organic cells. Sometimes it is empty, and is then contracted to such a degree as to appear like a knotted cylindrical cord, but when distended with ova, it takes the form in outline of the mass of the latter (*c*).

The ova within the oviduct are sufficiently strong and resistant to retain their oval form.

The uterine tube (*e*), formed by the conjunction of the oviducts, is cylindroid and

strongly muscular, and when contracted, is short, thick, and transversely contorted, and curves forward to the position of the generative aperture and the spermatheca, or when elongated, is narrow, relatively twice as long as in the other case, doubled upon itself, and first proceeds backward and then forward to the spermatheca, and is smooth. Its canal is narrow, closed when at rest, and is capable of transmitting but a single egg at a time.

The spermatheca (*f*), is a large oblong or long ovoid receptacle, situated ventrally and anteriorly to the generative aperture, and is connected at its posterior extremity by the termination of the uterus and commencement of the vagina, which conjoin at an acute angle to each other.

The vagina (*g*) curves downward, and terminates in an infundibuliform generative aperture, surrounded by a thick prominent lip (*h;* Pl. VI. 1, *g*). The parietes of the vagina are thick, strongly muscular, and transversely contorted.

The ripe ova are oval (Pl. VII. 14, *c*). The young *Ascarides* (22) have the same form as the parents. In them, the generative apparatus is entirely undeveloped.

The testicles (16, *b*) of the male are long, cylindroid, lobed organs, one upon each side of the posterior part of the intestinal canal, filled with oval spermatophori (18).

The spiculæ of the penis (19), are equal, scimetar-shaped, and are protruded immediately posterior to the anal aperture (17, *c*).

§ 3. Description of the Genus and Species of Hystrignathus.

HYSTRIGNATHUS, Leidy.

Body cylindroid, rigid, finely annulated; anterior annulations, excepting the first, furnished at their posterior margin with simple spines divergent backward. Oral annulus a truncated cone; mouth round. Tail pointed. Buccal organ long cylindrical; gizzard pyriform. Generative aperture of the female near the middle of the body. Ovum oval.

Hystrignathus rigidus, Leidy.

Proc. Acad. Nat. Sci., Phila., v., 102.

(Plate VII. 8–10.)

Female.—Body straight, rigid, elastic, cylindrical, white, translucent; anteriorly and posteriorly narrowed; anterior 106 annuli, extending a short distance posterior to the position of the commencement of the ventriculus, furnished at their posterior margin with 16 simple, conoidal, divergent spines; anterior spines equal in length to the width of the annuli, the posterior decreasing to mere points; posterior annuli of the body indistinct. Oral annulus deeply truncated, conical, naked. Mouth large, round; pharynx extending through the first two annuli; buccal organ (Pl. VII. 9, *a*) cylindrical, rounded at the extremities, extending through 56 annuli; gizzard (*b*) pyriform, with a cylindrical neck, narrower than the buccal organ, and a spherical

body extending through 12 annuli; intestine cylindrical, slightly dilated anteriorly, narrowing posteriorly; rectum elongated, inverted pyriform. Tail long, narrow, conoidal, curved. Generative aperture near the middle of the body, slightly prominent.

Measurements.—Length 2 lines; greatest breadth $\frac{1}{140}$ in.; tail $\frac{1}{40}$ in. long from the anus; anterior spinous portion of the body $\frac{1}{26}$ in. long; buccal organ $\frac{1}{50}$ in. long, $\frac{1}{520}$ in. broad; gizzard $\frac{1}{190}$ in. long, with the breadth of its body $\frac{1}{320}$ in. Anterior spines $\frac{1}{2000}$ in. long. Ovum $\frac{1}{214}$ in. long, $\frac{1}{545}$ in. broad.

Habitation.—Found within the ventriculus of *Passalus cornutus*, adhering by the mouth to the mucous membrane, most usually within the sacculi, and unless it be scraped out, may escape detection. Three or four individuals are frequently found within the short blind pouch at the commencement of the ventriculus. It exists pretty constantly in numbers of two or three to twenty, rarely more.

Although I have examined over a hundred individuals of *Passalus cornutus*, I have never found a single male of *Hystrignathus*.

§ 4. Description of the Genus and Species of Streptostomum.

STREPTOSTOMUM, Leidy.

Body cylindroid, with relatively few annuli, which are very long and distinct. Mouth large, circular, without lobes or other appendages; buccal organ and gizzard pyriform. Female generative aperture posterior to the middle. Tail very long, spiculate. Penis consisting of a single spiculum.

1. Streptostomum agile, Leidy.

Proc. Acad. Nat. Sci., iv., 230; and ib. v., 285.

(Plate VI. Fig. 5; VII. 2, 12.)

Female.—Body cylindroid, narrowed at the extremities, anteriorly conoidal, divided into from 60 to 90 annulations. Oral annulus broad, with a prominent labial margin; second annulus inflated at its anterior margin. Tail very long, very straight, or slightly sigmoid, or bent at the distal extremity, linear, spiculate, ensiform, acute, shining, but slightly flexible. Mouth round, simple; buccal organ robust, pyriform, extending through thirteen annuli; gizzard robust, pyriform, with its neck subdivided into a distinct subglobular portion, extending to the twenty-first annulus; intestine cylindrical, capacious, dilated oval at its commencement; rectum inverted pyriform. Generative aperture placed twenty-four annuli anterior to the anal aperture. Ovary double; ova oval.

Measurements.—Length of body 1 line; breadth at commencement of intestine $\frac{1}{118}$ inch; at middle $\frac{1}{96}$ inch. Tail $\frac{1}{15}$ inch long by $\frac{1}{888}$ inch broad at the middle. Buccal organ $\frac{1}{190}$ inch long by $\frac{1}{320}$ inch broad; gizzard $\frac{1}{220}$ inch long by $\frac{1}{310}$ inch broad. Ova $\frac{1}{333}$ inch long by $\frac{1}{400}$ inch broad.

Habitation.—Found within the large intestine of *Julus marginatus*, and less frequently within the ventriculus.

2. Streptostomum gracile, Leidy.

Proc. Acad. Nat. Sci., v., 100; ib. v., 285.

Syn. *Oxyuris Diesingii*, Hammerschmidt: Isis, 1838, 354, Taf. iv., Fig. 6.

Oxyuris Blattæ Orientalis, Hammerschmidt: Naturwissenschaftliche Abhandlungen von Haidinger, I. 284, Taf. x., Figs. 4, 7, 13–15.

Anguillula macrura, Diesing: Systema Helminthum, II. 134.

(Plate VII. Figs. 6, 7.)

Female.—Body cylindroid, attenuated from the middle anteriorly and posteriorly. Anterior annuli very long and movable upon one another; posterior annuli shorter and not so distinct. Oral annulus short, simple; second annulus long, constricted in the middle. Tail nearly one-third the length of the body, straight or curved, spiculate, shining. Mouth round, simple; buccal organ elongated pyriform, with the neck cylindroid, dilated at its commencement and middle, extending through ten annuli; gizzard with a narrow cylindroid neck and globular body, extending to the eighteenth annulus; intestine cylindroid, very largely dilated oval at commencement.

Measurements.—Length of body 1 line; breadth opposite the ventricular dilatation $\frac{1}{135}$ inch; greatest do. $\frac{1}{107}$ inch; just above anus $\frac{1}{300}$ inch. Tail $\frac{1}{40}$ inch long by the $\frac{1}{1300}$ inch broad at middle. Buccal organ $\frac{1}{150}$ inch long; gizzard $\frac{1}{215}$ inch long. Ovum oval, $\frac{1}{300}$ inch long, $\frac{1}{625}$ inch broad.

Habitation.—Found within the intestinal canal of *Blatta orientalis.*

§ 5. Description of the Genus and Species of Thelastomum.

THELASTOMUM, Leidy.

Body cylindroid, annuli moderately long. Oral annulus papillæform. Mouth small, circular, without lobes or other appendages; buccal organ long, cylindrical; gizzard pyriform. Tail moderately long, spiculate. Penis consisting of a single spiculum.

1. Thelastomum attenuatum, Leidy.

Proc. Acad. Nat. Sci., iv., 231; ib. v., 285.

(Plate VI. Fig. 4; VII. I, 23.

Female.—Body cylindroid, translucent white, shining, attenuated anteriorly from the commencement of the intestine, divided into from 140 to 160 annulations. Oral annulus minute, papillæform; second annulus small, compressed oval. Tail very straight, or slightly curved, slender, spiculate, acute. Mouth small, simple; its passage extending through two and a half annuli; buccal organ and gizzard extending through 55 annulations, the former, very long, cylindrical, rounded at

the extremities; the latter pyriform, with a short neck, and narrower than the buccal organ; intestine cylindrical, dilated, subcordiform at commencement; rectum inverted pyriform. Generative aperture 42 annulations anterior to the anal.

Measurements.—Length of body $\frac{1}{10}$ to $\frac{1}{8}$ of an inch; breadth at middle $\frac{1}{95}$ of an inch. Tail $\frac{1}{14}$ of an inch in length by $\frac{1}{1000}$ of an inch broad at middle. Buccal organ $\frac{1}{4}$ line long by $\frac{1}{535}$ of an inch broad; gizzard $\frac{1}{178}$ of an inch long.

Ova $\frac{1}{333}$ of an inch long by $\frac{1}{400}$ of an inch broad.

Habitation.—Found with *Streptostomum agile,* within the large intestine of *Julus marginatus.*

2. Thelastomum appendiculatum, Leidy.

Proc. Acad. Nat. Sci., v., 101; ib. 285.

Syn. *Oxyuris Blattæ orientalis,* Hammerschmidt: Naturwiss. Abhandl. von Haidinger, I. 284, Taf. x. Figs. 10–12 (*male,* 8, 9, 20?).

(Plate VII. Fig. 3.)

Female.—Body cylindroid, translucent white, attenuated anteriorly and posteriorly; divided into from 80 to 90 annulations. Oral and second annulus, as in the preceding species; terminal annulus with two short spines projecting backward. Tail straight, spiculate, one-fourth the length of the body. Mouth small, simple; its passage extending to the third annulus; buccal organ and gizzard extending to the thirtieth annulation; the former long, cylindrical; the latter pyriform; commencement of the intestine broad, cordiform, becoming cylindroid and sending off a large diverticulum. Generative aperture 26 annulations anterior to the anal.

Measurements.—Length of body 1 line to $\frac{1}{10}$ of an inch; breadth at commencement of the ventriculus $\frac{1}{100}$ of an inch; at middle $\frac{1}{80}$ of an inch; at anus $\frac{1}{160}$ of an inch. Tail $\frac{1}{4}$ of a line long by $\frac{1}{888}$ of an inch broad at middle. Buccal organ $\frac{1}{80}$ of an inch long; gizzard $\frac{1}{240}$ of an inch long. Ovum semi-oval, $\frac{1}{260}$ of an inch in length by $\frac{1}{666}$ of an inch broad.

Habitation.—Found with *Streptostomum gracile* in the intestinal canal of *Blatta orientalis.*

3. Thelastomum labiatum, Leidy.

Proc. Acad. Nat. Sci., v. 101; ib. 285.

(Plate VII. Fig. 13.)

Female.—Body cylindroid, transparent, anteriorly and posteriorly attenuated, divided into 140 annulations, of which the anterior are very strongly marked. Oral annulus inflated, six-lobed at the margin; second annulus constricted anteriorly. Tail straight, spiculate, very nearly half the length of the body. Mouth round, extending through one and a half annuli; buccal organ and gizzard extending to the fortieth annulus; the former cylindroid; the latter robust; intestine at commencement subcordiform.

Measurements.—Length $\frac{1}{2}$ of a line to $\frac{1}{20}$ of an inch; breadth $\frac{1}{200}$ of an inch. Length of tail $\frac{1}{40}$ of an inch. Buccal organ $\frac{1}{120}$ of an inch; gizzard $\frac{1}{320}$ of an inch. Ovum oval, $\frac{1}{333}$ of an inch long by $\frac{1}{500}$ of an inch broad.

Habitation.—Found within the ventriculus and large intestine of *Polydesmus virginiensis.*

4. Thelastomum robustum, Leidy.

Proc. Acad. Nat. Sci., v., 101; ib. 285.

Female.—Body white, cylindrical, narrowed anteriorly and posteriorly, divided into from 200 to 220 annulations. Oral annulus simple. Tail straight, little more than one-eighth the length of the body. Mouth round, simple; buccal organ and gizzard extending through forty annulations; intestine largely dilated oval at commencement. Generative aperture 70 annulations anterior to the anal.

Measurements.—Length of body 2 lines; breadth at the commencement of the intestine $\frac{1}{75}$ of an inch; at middle $\frac{1}{66}$ of an inch; just above the anus $\frac{1}{75}$ of an inch. Length of tail $\frac{1}{22}$ of an inch; breadth at middle $\frac{1}{1000}$ of an inch. Buccal organ $\frac{1}{50}$ of an inch long; gizzard $\frac{1}{175}$ of an inch. Ovum $\frac{1}{300}$ of an inch long by $\frac{1}{500}$ of an inch broad.

Habitation.—Intestinal canal of the larva of a lamellicorn coleopterous insect.

5. Thelastomum brevicaudatum, Leidy.

Proc. Acad. Nat. Sci., v., 208; ib. 285.

Female.—Body cylindroid, anteriorly rapidly narrowing from the commencement of the intestine, posteriorly abruptly rounded; with a very short spiculate tail.

Measurements.—Length of body to 2 lines; breadth at commencement of intestine $\frac{1}{75}$ of an inch; at middle $\frac{1}{80}$ of an inch; just above anus $\frac{1}{133}$ of an inch. Length of tail from anus $\frac{1}{200}$ of an inch. Buccal organ $\frac{1}{66}$ of an inch long; gizzard $\frac{1}{250}$ of an inch long. Ovum oval, $\frac{1}{285}$ of an inch long.

Habitation.—Intestine of the larva of *Scarabæus relictus.*

6. Thelastomum gracile, Leidy.

Proc. Acad. Nat. Sci., v., 285.

Oxyuris gracilis, Hammerschmidt: Isis, 1838, 353, Tab. IV. c–f; Naturwis. Abhandl. v. Haid. I. 287, Tab. X. Figs. 21–25.
Anguillula gracilis, Diesing: Syst. Helm. II. 133.

7. Thelastomum depressum, Leidy.

Oxyuris depressa, Hammerschmidt: Isis, 1838, 354, Tab. IV. d. e.
Oxyuris dilatata, Hammerschmidt: Naturwis. Abhandl. v. Haid. I. 287, Tab. X. Figs. 26, 27.
Thelastoma dilatatum, Leidy: Proc. Acad. Nat. Sci., v., 285.
Anguillula depressa, Diesing: Syst. Helm. II. 133.

8. Thelastomum laticolle, Leidy.

Proc. Acad. Nat. Sci., v., 285.

Oxyuris laticollis, Hammerschmidt: Naturwis. Abhandl. v. Haid. I. 288, Tab. X. Figs. 28–34.
Anguillula laticollis, Diesing: Syst. Helm. II. 134.

§ 6. History, Structure, etc., of Streptostomum, and Thelastomum.

In *Thelastomum*, the body is longer, has shorter and more numerous annulations, and a shorter tail than in *Streptostomum*. In the former, also, the buccal organ is relatively very long, and cylindrical, in the latter short and pyriform. In *Oxyuris* the body is relatively longer than in either the above, is more shortly and numerously annulated, and has the tail constructed like that of *Ascaris*, instead of being straight and spiculate, as in the former genera.

In *Ascaris* and *Oxyuris* the tail appears to be formed by the gradual attenuation of the body posteriorly to a point; in *Streptostomum* and *Thelastomum* it has more the appearance of being a superadded appendage, even in the species *Thelastomum brevicaudatum*, which has comparatively a very short tail.

In the two genera last mentioned, the tegumentary envelop of the body is so transparent that all the interior structures are distinctly visible. The integument is lined by two layers of muscular fibres, the first transverse, the second and stronger, longitudinal.

Within the muscular investment, apparently upon one side only, in *Streptostomum* just posterior to the commencement of the intestine (Pl. VII. 2, *e*), and in *Thelastomum* at the termination of the buccal organ (1, *e*), is an apparent follicle, communicating with the exterior, and having its bottom connected by means of radiating bands of fibres to the external surface of the alimentary canal in its vicinity.

Along the course of the interior ventral surface are situated several other apparently glandular organs (Pl. VI. 4, *e*).

The intimate structure of the alimentary canal presents nothing different from that given in the account of *Ascaris infecta*.

A remarkable special peculiarity in the construction of the intestine is observable in *Thelastomum appendiculatum*. In all other species of the genus, and in *Streptostomum*, the intestine is simply cylindroid, straight throughout, and more or less dilated into different forms at its commencement. In *Thelastomum appendiculatum* (Pl. VII. 3), the intestine commences by a broad, deeply sinuate cordiform dilatation, which rapidly narrows to a short cylindroid portion and then sends off a long, capacious, gourd-form receptacle, or diverticulum (*d*), and afterwards proceeds backwards to the rectum, and in its course, in the vicinity of the generative aperture, performs a single short convolution.

The generative apparatus (Pl. VI. 4) of *Streptostomum* and *Thelastomum* is constructed upon the same plan as that of *Ascaris infecta*, except that there is no spermatheca, and the dilatable portions of the oviducts terminate at once in the vagina, which passes obliquely backward, and ventrally to the generative aperture. (*d*)

CHAPTER III.

UPON PSEUDO-ENTOPHYTA, ETC.

TRUE free or unattached entophyta are comparatively rare, within the alimentary canal of animals, because they possess no means of counteracting expulsion with the ordinary contents of the bowels. They may, however, not unfrequently exist where they have a very rapid reproductive power, and are so small that many escape removal at any single expulsive effort of the organ which contains them.

The *Sarcina ventriculi,* Goodsir, is an entophyte of the latter character, which being very minute, and rapidly reproduced, is not easily expelled from the stomach under the circumstances in which it is found.

Vibriones, and closely allied but not spontaneously moving filaments, very frequently met with in the intestinal contents of herbivorous animals, are probably true floating or free entophyta, which by their very great minuteness and energetic reproductive power are prevented from entire removal from the alimentary canal.

In the study of the vegetable parasites of animals, particularly those of the intestinal canal, it is necessary to be careful not to confound the tissues of certain well-known cryptogamic plants, which may serve as food or adhere to the ordinary food of such animals, with true entophyta. Thus fragments of fungi, confervæ, lichenes, and the spores of these, used as food, or adhering as foreign matter to food of an ordinary kind, are liable within the intestine to be mistaken for parasites.

In midwinter, I found beneath an old fence-rail, an individual of *Acheta nigra,* or large black cricket, within the proventriculus of which were large quantities of what I supposed at the time to be a free, floating entophyte, resembling in general appearance the ordinary yeast fungus, *Torula,* but which I now suspect to be an ergot upon which the animal had fed (Pl. X. 8). The plant consisted of oblong or oval vesicular bodies, apparently thickened at the poles, and filled with a colorless liquid; but this appearance more probably arose from the cells being distended with a single large, transparent, colorless, amorphous globule, which pressed a small existing amount of protoplasma to each end of the cavity. The cells were single, or in rows to eighteen in number. Frequently, a single cell of comparatively large size had an attached pair of cells or rows of cells at one or both ends. Occasionally they were met with, containing one or two small round hyaline, amorphous nuclei.

The isolated cellules measured from the $\frac{1}{1500}$ to the $\frac{1}{1000}$ of an inch in length

by the $\frac{1}{8000}$ to the $\frac{1}{6000}$ of an inch in breadth. The rows measured up to the $\frac{1}{300}$ of an inch in length.

Of a doubtful character, as an entophyte, are also some vegetable bodies which I observed floating in a honey-colored liquid of the proventriculus of a larva of *Arctia Isabella*, a lepidopterous insect, which I found hybernating beneath a stone in the early part of the month of January.

These bodies in outline resemble the caudex, with its connected radicles, of certain phanerogamous plants (Pl. X. 26).

The caudex-like portion was irregularly oblong or fusiform, brown in color, opaque, and measured from the $\frac{1}{2500}$ to the $\frac{1}{625}$ of an inch long, and the $\frac{1}{10000}$ to the $\frac{1}{4000}$ of an inch broad.

The filaments were hyaline, cylindrical, irregular in their course, and branching. They rarely presented the appearance of a partition, and possessed amorphous or very faintly granular contents, with an occasional coarse, isolated granule. Their diameter was pretty uniformly about the $\frac{1}{11000}$ of an inch. Mixed with them, generally separated, frequently attached, were numerous sporuloid bodies, oblong in form, two or three times as long as they were broad, and having the same structure as the filaments.

The spores of many cryptogamic plants form a very frequent constituent of the ordinary contents of the bowels of many animals.

It is not improbable that an occasional new species of cryptogamic plant which grows externally, but has escaped observation, might be discovered in the examination of the contents of the intestine of such animals as the earth worms, herbivorous myriapoda, herbivorous insects, batrachians, and chelonians.

Among a variety of cryptogamic forms, which I have observed mixed with the contents of the bowels of a number of animals, are several, which, from the singularity of their appearance and the probable importance of directing attention to a source which may lead to the discovery of new external plants, I will briefly notice.

One of these is a long cylindrical articulated body, occasionally found mixed with the food of *Julus*, *Polydesmus*, *Passalus*, and *Lumbricus*. It is purplish-brownish in color, with from 9 to 14 articulations, slightly constricted at the conjunction of the latter. The extremities are obtusely angular, or one is prolonged into a sort of pedicle or foot-stalk, expanded at what is the free end in the specimens. The contents of the articulations consist of a central cylindroid, amorphous, transparent mass, or one or a few aggregated globules, inclosed in a darker amorphous matter which appears to be a continuous structure of the cell-wall (Pl. X. 4, 5).

The length of these bodies is about the $\frac{1}{225}$ of an inch by the $\frac{1}{2500}$ of an inch in breadth. The articulations are equal to the diameter, but are sometimes larger, up to the $\frac{1}{2142}$ of an inch in length.

A second remarkable vegetable organism was observed several times among the contents of the ventriculus of *Passalus cornutus* and *Julus marginatus*. This was a *Gonium*-like body, of a dark olive-brownish color, composed of from nineteen to twenty-seven articulations arranged in four rows side by side, the two outer uniting at one end in the form of U, and inclosing the other two, which, in some cases,

ceased on a level with the extremities of the arms of the U, at others projected two articulations beyond. The articulations were amorphous in structure, with from one to four minute, indistinct, nucleolar bodies (Pl. X. 6, 7).

They measured from the $\frac{1}{1000}$ to the $\frac{1}{750}$ of an inch in length by the $\frac{1}{1428}$ to the $\frac{1}{1200}$ of an inch in breadth, and had a thickness corresponding to the diameter of the articulations, which, on an average, was about the $\frac{1}{6000}$ of an inch.

In water, these bodies had a slight lateral oscillating movement.

Another curious body, probably a polyspore, I observed several times mixed with the food within the ventriculus of *Passalus cornutus* (Pl. X. 13). This was V-formed, articulated, translucent, and purplish-brown in color, and measured along each arm upon the outer side about the $\frac{1}{875}$ of an inch. It consisted of eight articulations, which were amorphous in structure. The articulation forming the apex was a small inverted cone, upon the base of which was placed the second articulation which terminated above in two oblique lateral faces, from each of which projected in a line three articulations forming the divergent arms of the body. The last articulation of the latter was long and spine-like.

Some cryptogamic spores, which may be taken into the alimentary canal with the food of the animal, may there commence their development into a mycelium, though belonging to plants which grow externally.

Of this character are certain sporular bodies which I have observed frequently existing among the contents of the cloaca of batrachian animals, the plant of which only completes its development exposed to the air upon the surface of the expelled excrement (14–25).

Generally, the sporular bodies, found under the circumstances just mentioned, are globular, and more or less extended upon one side into a cylindroid or clavate prolongation (14–21). Each extremity is almost always occupied by a single, large spherical, oval, or pyriform, hyaline, amorphous body, in the interspace of which the cell-like sporules are filled with a finely granular protoplasm.

Rarely do these bodies advance in their development within the animal more than has been just described, but occasionally a branching mycelium is met with, of small extent, consisting of oblong cellules attached by their rounded extremities (22). The contents of the cellules consist of a colorless liquid protoplasm, sometimes entirely, but generally occupying one extremity of the cells, while the other is filled by a mass of fine granular matter, with a small round hyaline, nuclear body.

Exterior to the animals, in the excrement, the vegetable bodies under consideration form an extensively ramifying, articulated mycelium, which sends up straight filaments into the air, producing at the free extremity one or more rows of oval, granular, sporular bodies (23). Filaments, also, of the mycelium are not unfrequently found, in which comparatively large globular spores have been developed, apparently by an accumulation of the entire granular matter, as it ordinarily exists, of a single articulation (24).

All the cryptogamic plants described in the preceding pages are innocent denizens of, or travellers through, the intestinal canal of animals. But, besides plants of this character, there are many parasitic fungi of animals which are entirely destructive to life. Such are the Muscardine, *Botrytis bassiana*, Balsamo, so injurious to the

silk-worm,[1] and several species of *Sphæria* and *Isaria*, which also grow within and upon insects and their larvæ.

These fungi grow with great rapidity within the body of the animal they attack, not only at the expense of the nutritive fluids of the latter, but, after its death, all the interior soft tissues appear to be converted into a solid mass of mycelium, from which arise one or more aerial receptacles of the spores.

I once found a specimen of *Gryllo-talpa americana*, sitting at the mouth of a hole beneath a log, apparently in perfect health, but, upon nearer examination, found it had been so completely invaded by a fungous mycelium that even the joints of the tarsi were distended with it.

The same kind of fungous substance I have observed distending the bodies of larvæ of several species of our indigenous lepidoptera, and once, also, the larva of a lamellicorn insect.

Of a closely analogous character is a fungus which I found to be very common in the seventeen-year locust, *Cicada septendecim*, under the following circumstances:—

In a number of the female insects, within the vagina and projecting externally, I frequently observed a moist, white, filamentous substance, which I supposed to be spermatic matter, but, upon examination, found to be composed of a mycelium of fungous filaments (Pl. X. Figs. 27, 28). Most of these were branching, inarticulate, from the $\frac{1}{9000}$ to the $\frac{1}{8600}$ of an inch in diameter, and were filled with a hyaline protoplasma, with an occasional isolated yellowish granule. Others were united to several oblong cells, or were continuous with what appeared to be the original spore, and contained a protoplasma, and hyaline amorphous globules. With the filaments were intermingled numerous round or oval spore-like bodies, from the $\frac{1}{1400}$ to the $\frac{1}{1000}$ of an inch in diameter, colorless, and with hyaline granular contents and one or several nuclei (29).

In the spring of 1851, during the imago appearance of the seventeen-year locust, among myriads of the insect, several friends and myself found between 12 and 20 specimens, which, though living, had the posterior third of the abdominal contents converted into a dry, powdery, ochreous-yellow, compact mass of sporuloid bodies. The caudal appendages and posterior two or three abdominal rings covering the mass, were loose and easily detached, leaving the fungoid matter in the form of a cone, affixed by its base to the unaffected part of the abdomen of the insect.

The sporuloid bodies, which constituted the entire mass, were oval or ovate in form, with a wrinkled surface, and faintly granular contents, and measured from the $\frac{1}{2800}$ to the $\frac{1}{1400}$ of an inch long, by the $\frac{1}{3500}$ to the $\frac{1}{2333}$ of an inch broad.

From the observations thus made upon the fungous disease of the seventeen-year locust, it is probable the insect is more liable to it than we can have any means of estimating. The fungus may commence its attack upon the larva of the insect, develop its mycelium, and produce a sporular mass within the active chrysalis, while ascending and descending its chimney to receive full benefit from the air, and in

[1] Eighteen years ago, a younger brother and myself, for our amusement, reared several thousand silk-worms, among which we often observed and carefully removed what we then called "mouldy silk-worms," or "silk-worms affected with the mould disease."

this stage destroy many which we, of course, never after see, because we never seek for them. If the fungus has invaded the insect only to such an extent as not to destroy organs immediately essential to its life, it may pass through its metamorphosis into the imago, but with the posterior part of the abdomen filled with a mass of fungous substance, as described above.

The reason of the fungous production being always found in the last-mentioned situation, arises, probably, from the fact that the access of the sporules to the interior of the animal is much easier through the generative and anal apertures than through the more delicate passage of the proboscis.

It is probable that this fungous disease of the seventeen-year locust is one of the means of maintaining the equilibrium in the aggregate of the life of the species under existing circumstances.[1]

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[1] I say under existing circumstances, for if these change, the species may be either increased or diminished, or even extinguished; but has not life in the aggregate ever been fixed in its extent? If so, then if a species be increased, diminished, or extinguished, the equilibrium of life in the aggregate has still been preserved by another or several other species having diminished, increased, or primitively originated.

INDEX OF SCIENTIFIC NAMES.

[Synonyms are in Roman.]

REFERENCES TO THE PLATES AND FIGURES.

PLATE I.

Fig. 1. Numerous thalli of *Enterobryus elegans*, growing from a portion of mucous membrane of the ventriculus of *Julus marginatus*. The breadth of the thalli, in the drawing, is greater than the relation of their length.

a. Mucous membrane, covered with hexahedral epithelial cells.

b. Primary cells of *Enterobryus*, filled with granules and globules.

c. Spiral turn performed by the thallus of *Enterobryus elegans* in its course of growth.

d. Extremity of a primary cell filled with granular matter.

e. Secondary cells, usually filled with granular matter.

f. One of the secondary cells burst, with an escape of the mixed liquid and granular contents.

g. *Arthromitus*, a frequent parasitic algoid plant upon *Enterobryus*.

h. Pedicle of attachment of *Enterobryus*.

i. A thallus in outline, terminated by a single secondary cell.

Fig. 2. Thalli of *Enterobryus attenuatus*, growing from a shred of basement-membrane, from the ventriculus of *Passalus cornutus*, magnified about twenty diameters.

Fig. 3. Five thalli of *Enterobryus attenuatus*, very highly magnified.

a. Basement-membrane of the mucous membrane of the ventriculus of *Passalus cornutus*.

b. Primary cells, filled with the characteristic contents of liquid, granules, and globules.

c. Pedicle.

d. A few filaments of *Arthromitus*, parasitic upon the *Enterobryus*.

Fig. 4. Four thalli of *Enterobryus spiralis*, growing from a portion of mucous membrane, from the ventriculus of *Julus pusillus*.

a. Hexahedral epithelia of the mucous membrane.

b. Thalli of *Enterobryus*, exhibiting the spiral arrangement and internal structure.

c. Primary cell.

d. Secondary cells.

e. Pedicle of attachment.

PLATE II.

Fig. 1. Numerous thalli of *Enterobryus elegans*, growing from a portion of mucous membrane of the ventriculus of *Julus marginatus*.

a. Outline of the portion of mucous membrane.

b. Cylindrical epithelial cells of the mucous membrane.

c. Young thalli of *Enterobryus*, filled with the characteristic contents of liquid, globules, and a relatively small quantity of granules.

d. Pedicle of attachment.

e. Masses of parasitic, granulo-filamentous, phytoid matter, growing upon the mucous membrane.

f. The same kind of matter, growing upon the *Enterobryus*.

g. *Cladophytum*, parasitic upon the granulo-filamentous matter.

h. *Cladophytum*, parasitic upon the *Enterobryus*.

i. Bunches of *Arthromitus cristatus*, growing in similar positions as the *Cladophytum*.

Fig. 2. Portion of the mucous membrane of the lower extremity of the large intestine of *Julus marginatus*, with very numerous young thalli of *Enterobryus elegans*.

a. Mucous membrane in outline.

b. Epithelia.

c. Young thalli of *Enterobryus*, in outline.

d. Two thalli, with granular contents and a very few globules.

Fig. 3. A single young thallus of *Enterobryus elegans*, from the same position as Fig. 2, but more magnified, so as to exhibit the contents.

a. The primary cell, with granular contents and a few globules.

b. The pedicle.

Fig. 4. A single individual of *Enterobryus elegans*, from the ventriculus of *Julus marginatus*, artificially twisted, exhibiting well the appearance of the interior contents.

a. The primary cell.

b. Its watch-crystal like termination.

c. The pedicle of attachment.

PLATE III.

Exhibits the structure of *Enterobryus*.

Fig. 1. Distal portion of a primary cell, with an unusually short attached secondary cell of *E. elegans*.

a. The portion of the primary cell filled with granules and globules.

b. A secondary cell, filled with granules. The distal extremity of this cell is abruptly terminated, and the cell-membrane rises like the crystal of a watch from its dial.

Fig. 2. Central portion of a primary cell distended with globules. A few very minute granules are visible.

Fig. 3. Proximal or attached portion of a primary cell.

a. Portion of the primary cell; its lower end slightly dilated, filled with globules and granules.

b. Portion of the pedicle.

Fig. 4. Dilated distal extremity of a primary cell, filled with globules; the latter, in the upper portion, polyhedral from pressure.

Fig. 5. Central portion of the same cell containing granules and globules.

Fig. 6. Proximal portion of the same thallus.

a. Portion of the principal cell filled with granules and globules.

b. The pedicle.

c. Its expanded basis of attachment.

Fig. 7. Distal portion of a primary cell, filled with granules and globules, its upper end terminating abruptly, with the cell-membrane rising like the crystal of a watch.

Fig. 8. Central portion of the same thallus, filled with granules and very large globules.

Fig. 9. Proximal portion of the same thallus.

a. Portion of the primary cell, filled with granules mixed with a few globules.

b. The pedicle of attachment, with four transverse contortions.

c. Its expanded base of attachment.

Fig. 10. Middle portion of a primary cell, very highly magnified, containing globules and granules.

Fig. 11. Proximal portion of the same individual as the last.

a. Portion of the primary cell, with globules and granules.

b. The pedicle, cut off below.

Fig. 12. Distal portion of a primary cell, clavate in form, filled with granules and globules, and having its summit crowned with a profuse bunch of *Arthromitus*.

Fig. 13. Distal extremity of a primary cell of *Enterobryus elegans*, distended with a single row of large globules.

Fig. 14. Do. clavate in form, distended with large polyhedral globules.

Fig. 15. Distal extremity of a thallus of *Enterobryus attenuatus*, with a short secondary cell.

a. Portion of the primary cell, filled with protoplasma, granules, and a few globules.

b. Secondary cell, burst at its upper extremity, and allowing globules of the protoplasma and granules to escape.

Fig. 16. Distal extremity of an individual with a longer secondary cell.

a. Portion of the primary cell, with granules and a few globules.

b. Secondary cell filled with protoplasma, containing a few scattering granules.

Figs. 15 and 16 are representations of the only two instances of secondary cells which I ever observed in *Enterobryus attenuatus*.

Fig. 17 represents the distal portion of a number of individuals of *Enterobryus attenuatus*, exhibiting the variations of the interior structure.

a. Distended with globules, varying in size in different individuals, but very uniform in the same individual.

b. Filled with granules and globules irregular in size.

c. Outline of a portion of the primary cell.

d. Thickening of the cell-wall around the margin of the free extremity.

PLATE IV.

Fig. 1. A dead thallus of *Enterobryus elegans*.

a. The pedicle.

b. The primary cell.

c. The contracted or shrunken primordial utricle.

d. Oil-like globules.

e. Branches of *Cladophytum*.

Fig. 2. Distal extremity of a thallus, with the contents shrunken from the application of acetic acid.

Fig. 3. Spores? of *Enterobryus elegans*.

Figs. 4–17. Young thalli of *Enterobryus elegans*.

Fig. 4. Very young condition: Length $\frac{1}{1500}$ inch.

a. Point of attachment.

Figs. 5, 6. Further advanced: Length $\frac{1}{880}$ inch.

a. Young primary cell.

b. Pedicle.

Fig. 7. Young thallus constricted at the middle: Length $\frac{1}{535}$ inch; breadth $\frac{1}{2000}$ inch.

Fig. 8. Young thallus: Length $\frac{1}{380}$ inch; breadth $\frac{1}{1000}$ inch.

a. Pedicle.

Fig. 9. Do. constricted at the lower portion of the primary cell, which is filled with protoplasma, granules, and a few globules: Length $\frac{1}{230}$ inch.

Fig. 10. Do. curved, clavate, distended with globules: Length $\frac{1}{160}$ inch.

Fig. 11. Do. same form as last: Length $\frac{1}{60}$ inch.

Fig. 12. Do. $\frac{1}{75}$ inch long.

Fig. 13. Do. straight, clavate, distended with globules: Length $\frac{1}{115}$ inch.

Fig. 14. Do. long, straight, and clavate: Length $\frac{1}{60}$ inch.

Fig. 15. Do. constricted at its upper third: Length $\frac{1}{60}$ inch.

a. Pedicle.

b. Epithelial cells of the mucous membrane.

Fig. 16. Three young thalli growing from a portion of mucous membrane, from a young *Julus marginatus*, one inch long.

a. Primary cell, filled with globules: Length $\frac{1}{200}$ inch.

b. Do. clavate in form: Length $\frac{1}{300}$ inch.

c. Do. overgrown with *Arthromitus*: Length $\frac{1}{750}$ inch.

d. *Cladophytum*.

e. Basement-membrane.

f. Epithelial cells.

Fig. 17. Do. geniculate, $\frac{1}{100}$ inch long.

Fig. 18. Distal portion of an ultimate secondary cell of *Enterobryus elegans*, filled with granules and a few globules, and having a tuft of *Cladophytum* growing from the summit.

Fig. 19. Proximal portion of the ultimate cell (*a*), and distal portion of the penultimate cell (*b*), of the same individual as Fig. 18, filled with granules.

Fig. 20. Proximal portion of the penultimate cell (*a*), filled with granules, and distal portion of the primary cell (*b*), filled with granules and globules.

Fig. 21. Distal portion of an ultimate cell, filled with granules.

Fig. 22. Proximal portion of an ultimate cell, filled with granules (*a*), and distal portion of the penultimate cell, filled with globules and granules (*b*).

c. Point of division of the two secondary cells.

Fig. 23. Proximal portion of the penultimate cell (*a*), and distal portion of the primary cell (*b*), filled with granules and globules.

c. Line of separation of the primary from the secondary cells.

Fig. 24. Distal extremity of a secondary cell, filled with granules.

Fig. 25. Proximal extremity of the same cell, filled with granules (*a*), and distal portion of the primary cell, filled with granules and a few globules (*b*).

c. Line of separation between the primary and secondary cell.

Fig. 26. A young thallus of *Enterobryus attenuatus*, having an abnormal bud-like prominence at the attached extremity of the primary cell. Large globules distend its upper half; small ones its sigmoid flexure, and protoplasma fills the attached end and the bud. Length $\frac{1}{12}$ of an inch.

a. Primary cell.

b. Bud.

c. Pedicle.

Fig. 27. A bunch of *Enterobryus attenuatus*, in which the primary cells are of very nearly uniform diameter throughout, growing from a portion of basement-membrane. Length 1 line.

a. Principal cells, filled with globules, granules, and protoplasma; the lower portions, excepting one, in outline.

b. An individual, in which two principal cells grew from one pedicle. The only instance of the kind I ever met with.

c. Pedicle.

d. *Cladophytum.*

e. Basement-membrane.

Fig. 28. Large bunch of *Enterobryus elegans*, growing from a portion of mucous membrane.

a. Primary cells.

b. Penultimate secondary cell.

c. Ultimate secondary cell.

d. Pedicle of attachment.

e. Thallus in outline.

f. Bunches of *Cladophytum comatum.*

g. Basement-membrane.

h. Epithelial surface.

PLATE V.

Figs. 1, 2. Secondary cells of *Eccrina longa.* All were filled with granular matter.

Fig. 1. *a.* A distal extremity of the primary cell, filled with granules and globules.

b. Outlines of secondary cells.

c. Secondary cell, filled with granules.

Fig. 2. *a.* Outlines of secondary cells.

b. Secondary cells, filled with granules.

c. Thickening of the cell-wall at the place of division of the secondary cells.

Fig. 3. *a.* Distal portion of the primary cell of *Eccrina longa,* filled with granules and globules.

b. First secondary cell, filled with granules.

c. Outline of second secondary cell.

d. *Arthromitus* growing from *Eccrina.*

e. Its nucleus of attachment.

f. A tuft of *Cladophytum.*

g. Its nucleus of attachment.

Fig. 4. Terminal secondary cells of the same thallus as Fig. 3.

a. Filled with granules.

b. In outline.

Fig. 5. Secondary cells of *Eccrina longa.*

a. In outline.

b. Filled with granules.

c. Detached cells, which appear to adhere by one end to the sides of the parent thallus.

Fig. 6. Three detached secondary cells.

a. Filled with globules and granules.

b. In outline.

Fig. 7. Young thallus of *Eccrina longa* distended with globules; its upper part considerably dilated.

Figs. 8–13. Different forms assumed by the young of *Eccrina longa.*

Fig. 8. $\frac{1}{214}$ inch long; 9, $\frac{1}{430}$ inch; 10, $\frac{1}{214}$ inch; 11, $\frac{1}{250}$ inch; 12, $\frac{1}{214}$ inch; 13, more highly magnified, $\frac{1}{100}$ inch.

Fig. 14. *Arthromitus cristatus,* from the large intestine of *Julus marginatus.*

a. Nucleus of origin.

b. Mucous membrane.

c. Consolidated articuli.

d. Spores.

e. *Cladophytum.*

Fig. 15. Portion of another individual, more highly magnified.

a. Developing sporules.

b. Ripe sporules.

PLATE VI.

Fig. 1. An individual of *Ascaris infecta,* which had a large number of thalli of *Enterobryus elegans* growing upon it.

a. Buccal organ.

b. Gizzard.

c. Intestine.

d. Rectum.

e. Anus.

f. Ovary.

g. Generative aperture.

h. Bunches of *Arthromitus* growing upon the thalli of *Enterobryus.*

Fig. 2. Anterior portion of the body of *Ascaris infecta,* with three thalli of *E. elegans* growing upon it.

a. Lobes of the mouth.

b. Buccal organ.

c. Gizzard.

d. Commencement of intestine.

e. Ganglia.

f. Primary cells of *Enterobryus,* filled with granules and globules, and having very numerous bunches of *Arthromitus* growing upon them.

g. Pedicle of attachment.

Fig. 3. Portion of a thallus, with numerous bunches of *Arthromitus cristatus* growing upon it.

Fig. 4. Middle portion of the body of *Thelastomum attenuatum*, with two thalli of *Enterobryus* growing from it.

a. Intestine; the spots represent its epithelial cells.

b. Oviduct.

c. Vagina.

d. Generative aperture.

e. Tegumentary glands.

f. *Enterobryus.*

g. Pedicle.

h. *Arthromitus.*

i. Bunch of *Arthromitus* growing from the generative aperture.

Fig. 5. Posterior portion of the body of *Streptostomum agile.*

a. Annuli of the body.

b. Tail, cut off below.

c. Posterior extremity of the intestine, with the hexahedral epithelial cells visible.

d. Rectum.

e. Anus.

f. Bundles of muscular fibres.

g. Portion of the oviduct containing an ovum.

h. *Enterobryus elegans.*

i. Bunches of *Arthromitus cristatus.*

Fig. 6. Side view of the posterior extremity of *Ascaris infecta.*

a. Portion of the intestine.

b. Rectum.

c. Anus.

d. Portion of *Enterobryus elegans*, with a very long pedicle of attachment (*e*).

Fig. 7. Posterior view of the posterior extremity of *Ascaris infecta.*

a. Intestine.

b. Rectum.

c. Young thallus of *Enterobryus*, with a very long pedicle (*d*), growing from the tail.

e. *Arthromitus cristatus.*

f. *Cladophytum comatum.*

Fig. 8. Alimentary canal of *Passalus cornutus.*

a. Proventriculus.

b. Ventriculus.

c. Intestine.

Fig. 9. Ventriculus of *Passalus.*

a. Commencement.

b. Cæcal pouch opening into the ventriculus.

Fig. 10. Inferior portion of the ventriculus laid open.

a. The mouths of the sacculi.

b. The longitudinal folds.

c. The transverse folds.

d. V-shaped corneous plates.

e. Commencement of the fecal intestine.

PLATE VII.

Fig. 1. Anterior extremity of *Thelastomum attenuatum.*
a. Buccal organ.
b. Gizzard.
c. Commencement of the intestine.
d. Nervous ganglia.
e. Tegumentary follicle; respiratory?
f. Tegumentary gland..
Fig. 2. Anterior extremity of *Streptostomum agile.*
a. Buccal organ.
b. Gizzard.
c. Commencement of the intestine.
d. Portion of the anterior ovary.
e. Follicle; respiratory?
Fig. 3. Anterior portion of the body of *Thelastomum appendiculatum.*
a. Buccal organ.
b. Gizzard.
c. Intestine.
d. Diverticulum of the intestine.
e. Portion of the anterior ovary.
Fig. 4. Ovum of *Thelastomum appendiculatum.*
Fig. 5. Group of *Ascaris infecta,* adhering by their mouths to a shred of epithelium, from the ventriculus of *Julus marginatus.*
a. Male.
b. Female.
Fig. 6. Outline of *Streptostomum gracile.*
Fig. 7. Anterior portion of the body of *Streptostomum gracile.*
a. Buccal organ.
b. Gizzard.
c. Commencement of the intestine.
d. Portion of the anterior ovary.
e. Phytoid filaments growing from the integument.
Fig. 8. Anterior extremity of *Hystrignathus rigidus.*
a. Papilla of the mouth.
b. Buccal organ.
c. Spinous appendages.
Fig. 9. Anterior extremity of *Hystrignathus rigidus.*
a. Buccal organ.
b. Gizzard.
c. Commencement of the intestine.
Fig. 10. Posterior extremity of *Hystrignathus rigidus.*
a. Posterior portion of intestine.
b. Rectum.
c. Anus.
d. Portion of the posterior ovary.
Fig. 11. Position of copulation of *Ascaris infecta.*
a. Male.
b. Female.
Fig. 12. *Streptostomum agile,* with *Enterobryus elegans* and *Arthromitus cristatus* growing upon it.
a. Buccal organ.

b. Gizzard.
c. Intestine.
d. Oviduct filled with ripe ova.
e. Rectum.
f. Anus.
g. Tail.
h. *Enterobryus elegans.*
i. *Arthromitus cristatus.*

Fig. 13. Anterior extremity of *Thelastomum labiatum.*
a. The lobed lip.
b. The buccal organ.

Fig. 14. Portion of the female generative apparatus of *Ascaris infecta.*
a. Ovary.
b. Pyriform commencement of the oviduct.
c. Mass of ripe ova, viewed by reflected light.
d. Termination of the anterior oviduct, in outline.
e. Uterus, with an ovum at its termination, viewed by transmitted light.
f. Spermatheca.
g. Vagina.
h. Generative aperture.

Fig. 15. Tail of *Streptostomum agile,* with a growing thallus of *Enterobryus elegans* (*a*).

Fig. 16. Portion of the body of the male of *Ascaris infecta.*
a. Intestine.
b. Testicle.

Fig. 17. Posterior extremity of the male of *A. infecta.*
a. Intestine.
b. Testicle.
c. Penis.

Fig. 18. Spermatophori of *A. infecta.*

Fig. 19. One of the spiculæ of the penis of *A. infecta.*

Fig. 20. Outline of the posterior extremity of *A. infecta,* exhibiting the ventral tubercles.

Fig. 21. Alimentary canal of *Julus marginatus,* magnified two diameters.
a. Conglomerated salivary glands.
b. Tubular salivary glands, at their terminal portion.
c. Œsophagus.
d. Proventriculus.
e. Biliary tubes.
f. Fatty band.
g. Ventriculus.
h. Large intestine.
i. Rectum.

Fig. 22. Young of *Ascaris infecta.*

Fig. 23. Young of *Thelastomum attenuatum.*

PLATE VIII.

Fig. 1. A transverse fold of the ventriculus of *Passalus cornutus,* with numerous hair-like appendages covered with granulo-filamentous phytoid matter, and bunches of *Cladophytum* and *Corynocladus.*

a. Mucous membrane.
b. Hairs.
c. Phytoid substance.
d. Cladophytum comatum.
e. Corynocladus radiatus.
f. Arthromitus cristatus.

Fig. 2. Portion of the mucous membrane of the ventriculus of *Julus marginatus,* with patches of granulo-phytoid matter growing upon it.

a. Patches of granulo-phytoid matter.
b. Harder nuclei of phytoid matter.
c. Bunches of *Cladophytum comatum.*
d. Arthromitus cristatus.
e. Epithelial surface.
f. Basement-membrane.

Fig. 3. Portion of *Enterobryus elegans,* with two large bunches of *Arthromitus cristatus,* and a tuft of *Cladophytum.*

Fig. 4. Portion of *Enterobryus elegans,* overgrown with profuse bunches of *Arthromitus cristatus.*

Fig. 5. Summit of a hair-like appendage, from which grow numerous filaments of *Arthromitus* and other finer phytoid filaments, from the ventriculus of *Passalus cornutus.*

Fig. 6. Summit of a primary cell of *Enterobryus elegans,* from which grows a bunch of *Cladophytum comatum.*

Fig. 7. Two branches of *Cladophytum,* exhibiting minute ramuli.

Fig. 8. Bunch of *Cladophytum comatum,* and several long filaments of *Arthromitus* growing from a portion of the mucous membrane of the ventriculus of *Julus marginatus.*

PLATE IX.

Fig. 1. Represents a portion of the inner surface of the ventriculus of *Passalus cornutus,* with its numerous hair-like appendages enveloped in a parasitic, granulo-filamentous, phytoid substance.

a. Light shading, representing the bottom of the sacculi of the ventriculus, furnished with short hairs.
b. Broad transverse folds of the mucous membrane, between the sacculi.
c, d. Longitudinal folds separating the sacculi, and presenting on each side, between the position of the transverse folds, a column of closely-set, simple, bidentate, and tridentate corneous spines.
e. Long hair-like appendages, which border the ventricular sacculi and become the nuclei of large masses of growing phytoid matter.
f. Short hairs, everywhere studding the mucous membrane, and also enveloped with phytoid matter.

Fig. 2. Portion of a transverse fold of mucous membrane, from between the ventricular sacculi of *Passalus cornutus,* with its hair-like appendages enveloped in phytoid matter exhibited of the natural colors.

a. Mucous membrane.
b. Hair-like appendages.
c. Granulo-filamentous phytoid matter.
d. Bunches of *Cladophytum.*
e. Bunches of *Corynocladus.*

PLATE X.

Fig. 1. *Corynocladus radiatus*, from the ventriculus of *Passalus cornutus*.

a. Trunk.

b. Clavate branches.

c. Investment of granular phytoid matter; sporular?

d. Arthromitous filaments.

Fig. 2. Extremity of a branch of *Corynocladus*, very highly magnified, exhibiting the manner in which adhering matter appears dimly shaded, consisting, probably, of spores of the plant.

Fig. 3. Three filaments of a doubtful nature, whether vegetable or part of the animal structure of the ventriculus of *Passalus cornutus*, formerly called, by me, *Cryptodesma tenuis*.

Fig. 4. Polyspore? from the ventriculus of *Polydesmus granulatus*, found mixed with the food.

Fig. 5. Inferior portion of another individual from the same situation.

Figs. 6, 7. Polyspores? found mixed with the food in the ventriculus of *Passalus cornutus*.

Fig. 8. Ergot, *Ergotætia abortifaciens?* found in the proventriculus of *Acheta nigra*.

Figs. 9–12. In dead individuals of *Julus marginatus*, within the ventriculus and large intestine, I frequently observed a fungus in the form of small, white, translucent, compressed, spheroidal bodies, growing upon the mucous membrane, or upon dead filaments of *Enterobryus* lying upon the mucous membrane. The centre of these bodies was depressed, and the surface covered with fine longitudinal striæ, intersected by short transverse striæ. By reflected light, they resembled minute bleached shells of Echini. They measured from the $\frac{1}{1500}$ to the $\frac{1}{300}$ of an inch broad. Upon pressure, they burst or dehisced into several leaf-like finely-striated lobes, and exuded a clear but faintly granular liquid.

Fig. 9. Two of the fungous bodies, just described, viewed by reflected light.

Fig. 10. A group of the same bodies growing upon a filament of *Enterobryus*, also viewed by reflected light.

Fig. 11. One of these bodies viewed by transmitted light.

Fig. 12. One of these bodies burst into six leaf-like lobes from pressure.

Fig. 13. A polyspore? from the large intestine of *Julus marginatus*.

Figs. 14–21. Fungous sporuli, in various stages of development, found in the fecal contents of the large intestine of *Salamandra erythronota*, *S. salmonea*, *Triton niger*, *etc.* They are probably found in the cloaca of all the Salamanders.

Fig. 14. Much more highly magnified than the others.

Figs. 18, 20, 21. In outline.

Figs. 14–17, 19.

a. Granular matter.

b. Transparent liquid.

Fig. 22. Fungus mycelium, found growing in the cloaca of *Triton niger*.

a. Colorless liquid.

b. Granular contents.

c. Nuclei.

d. Phytoid filaments, at the basis of which was a quantity of adherent granular matter.

The small isolated lines represent a species of *Bacterium*, which existed in vast numbers.

Fig. 23. Fungus developed from the spores of Figs. 14–21, and the mycelium, Fig. 22, upon the dung of Salamanders when exposed to the external air. A species of *Torula*, or perhaps *Briarea?*

a. Spores.

b. Spores in outline.

c. Receptacle.

d. Mycelium.

Fig. 24. Portion of mycelium, with contained spores, of the same fungus as Fig. 23.

a. Spore.

b. Spore in outline.

c. Mycelium.

d. Shrivelled portion of mycelium.

Fig. 25. Spores found upon the dung of Salamanders.

Fig 26. Fungoid body found within the ventriculus of a hybernating larva of *Arctia Isabella.* Probably the tissue of some fungus, which may have served the animal as food.

Figs. 27, 28. Fungus mycelium, from the vagina of *Cicada septendecim.*

Fig. 29. Spores from the same situation as Figs. 27, 28.

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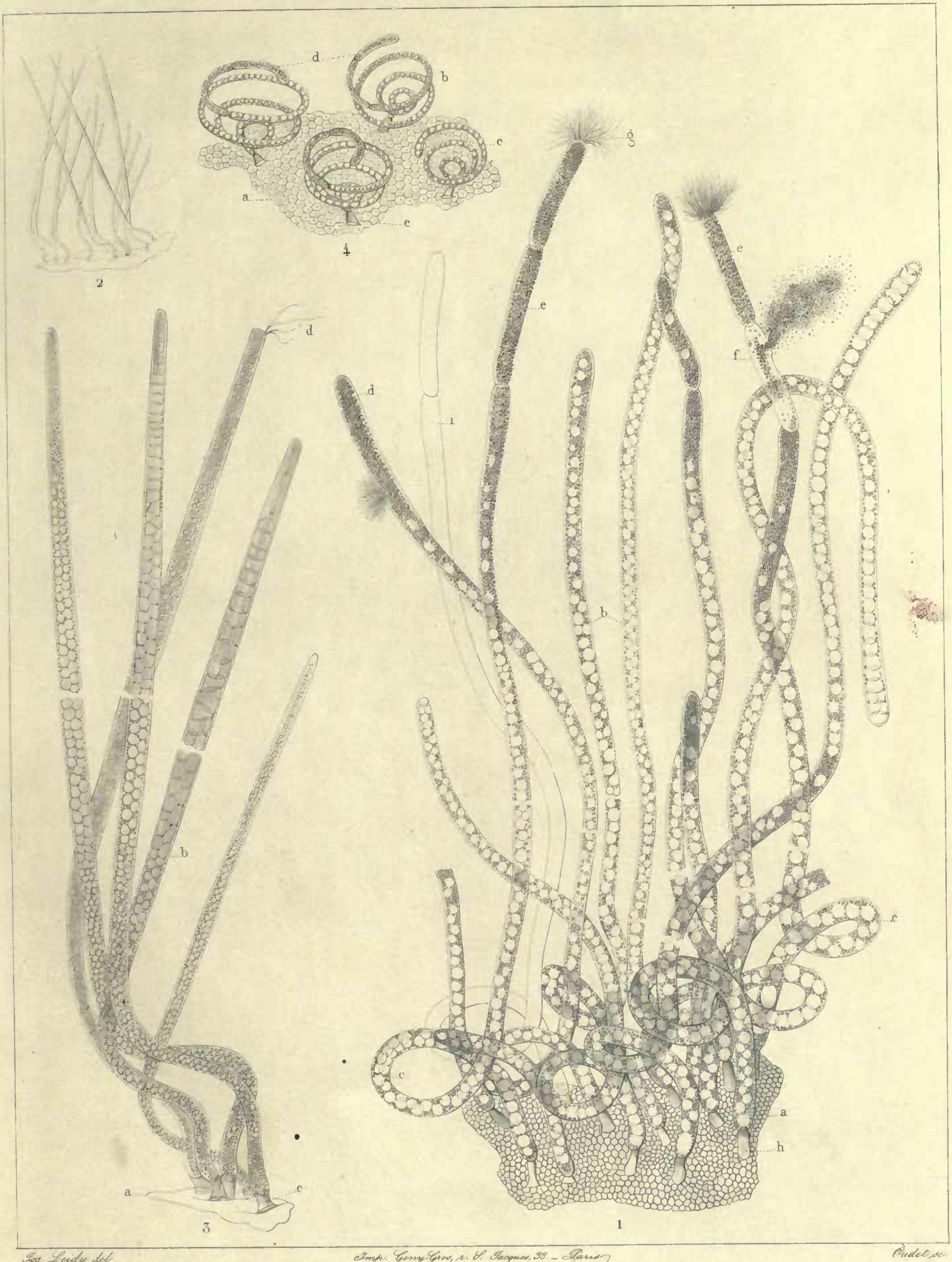

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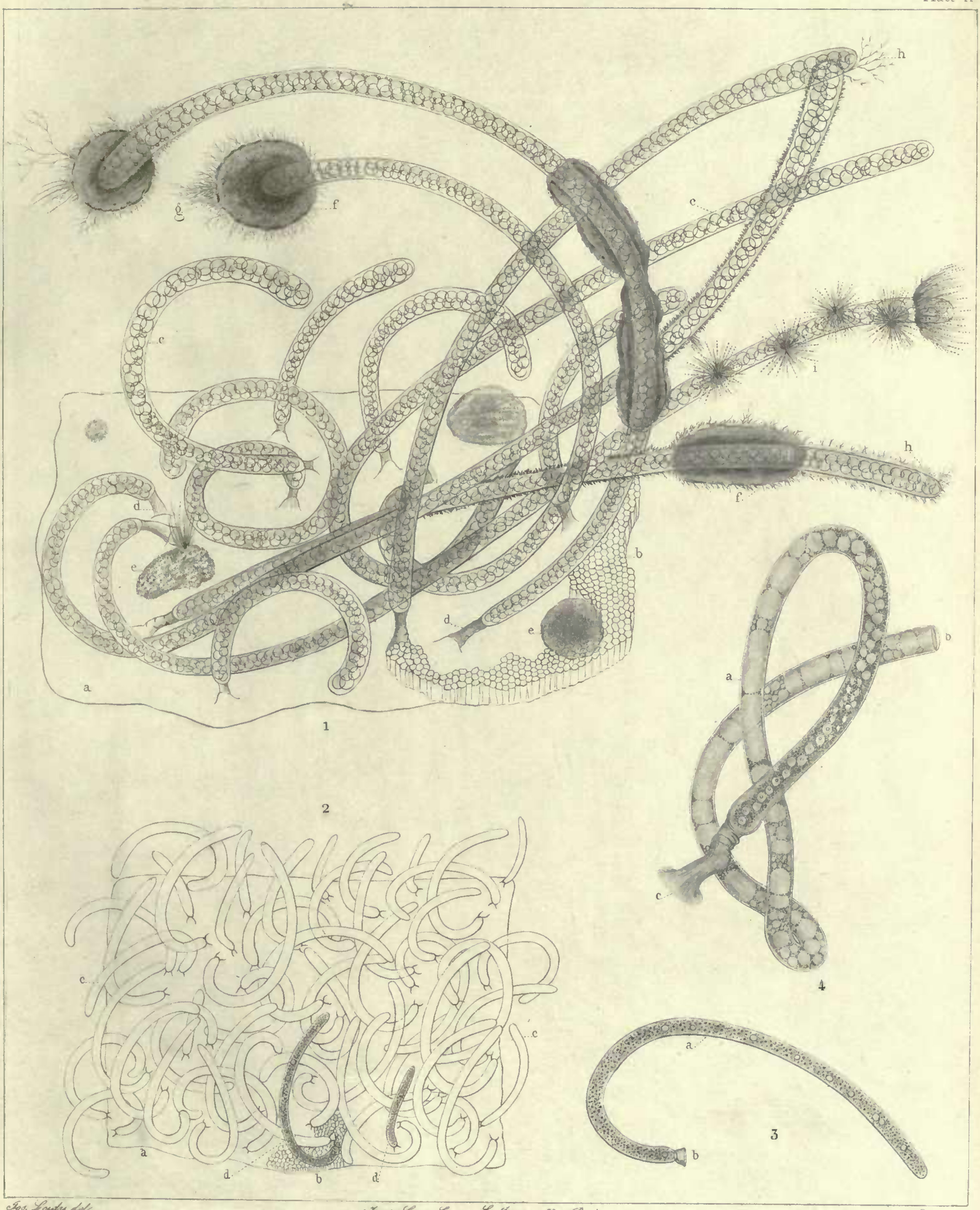

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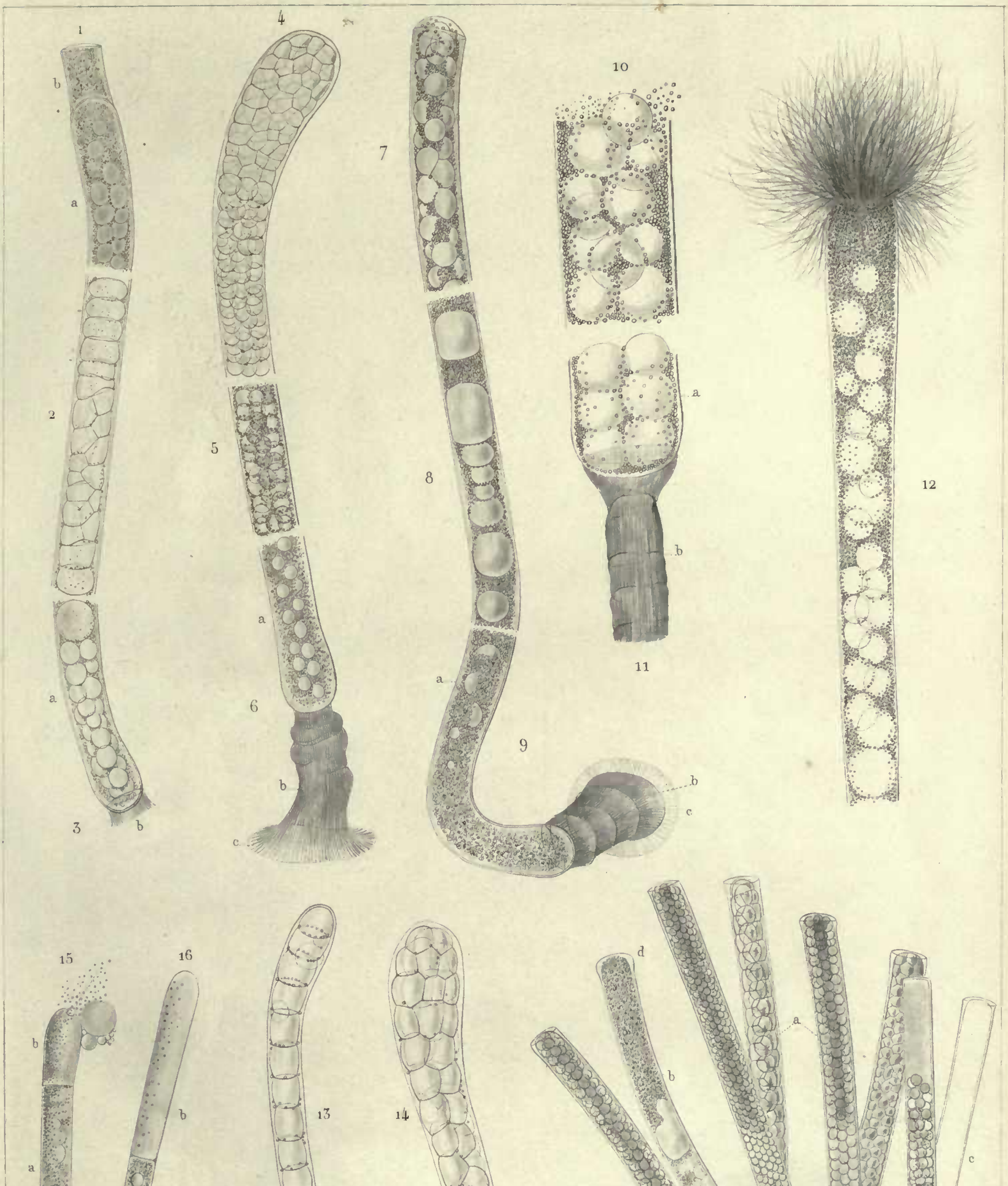

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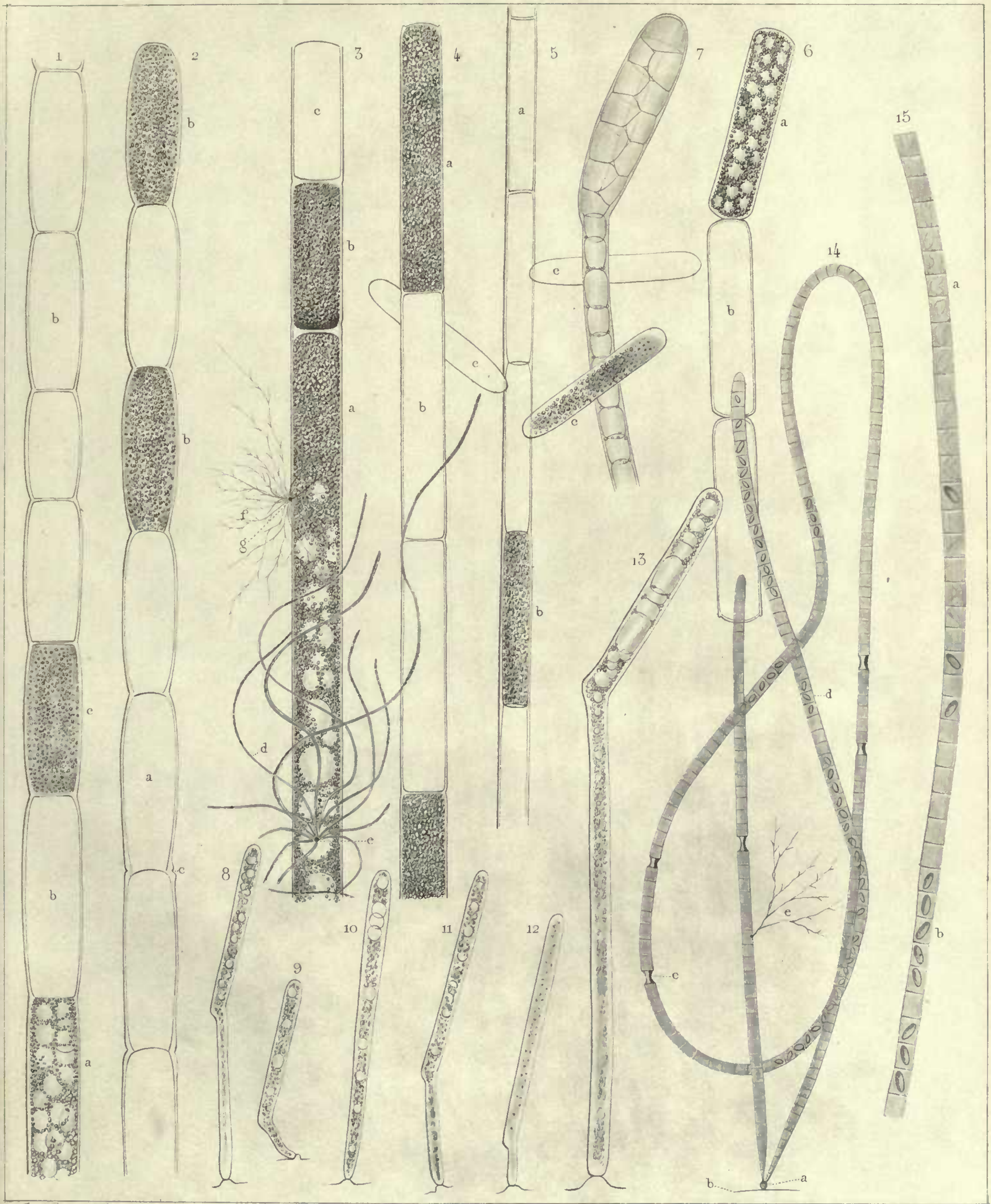

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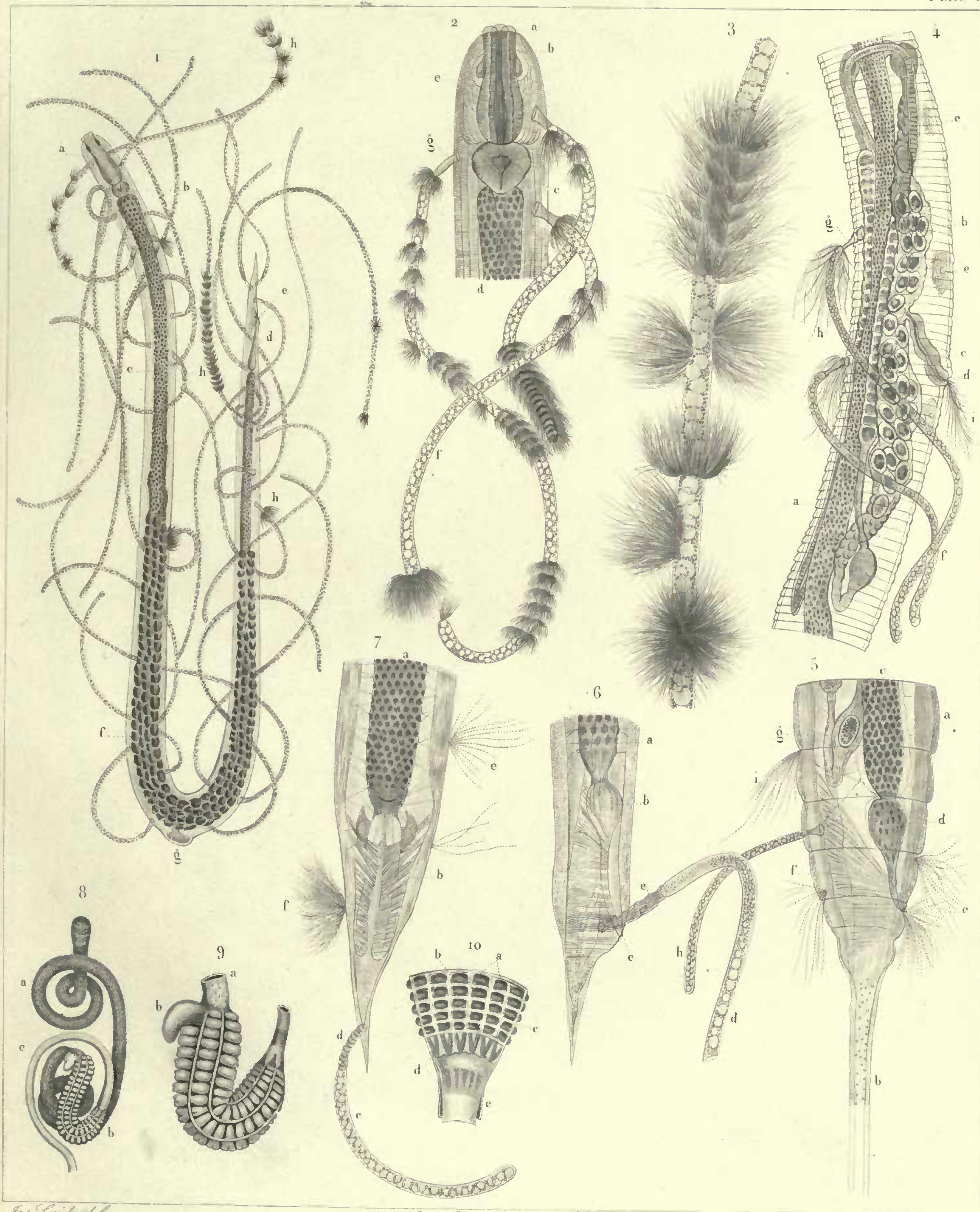

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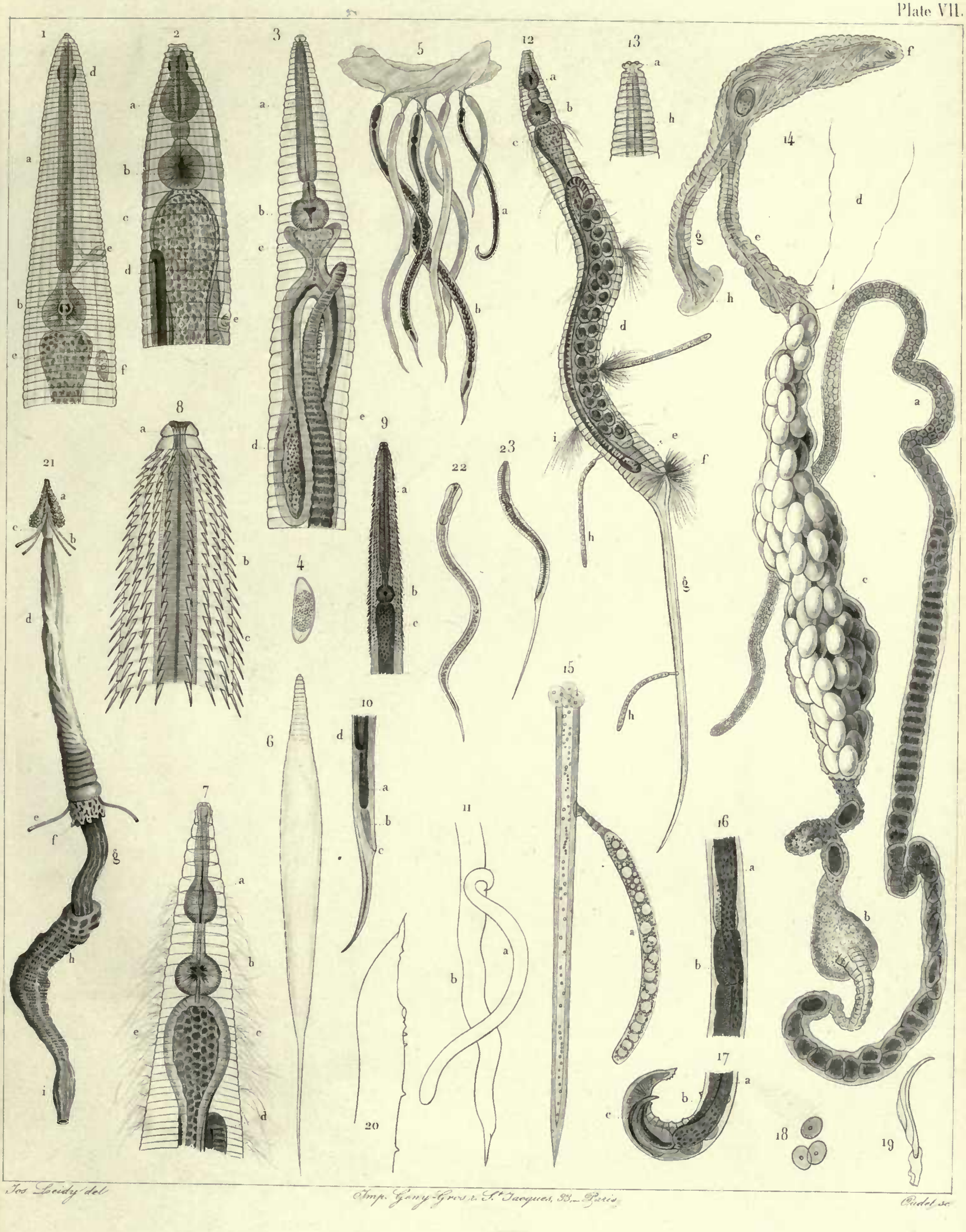

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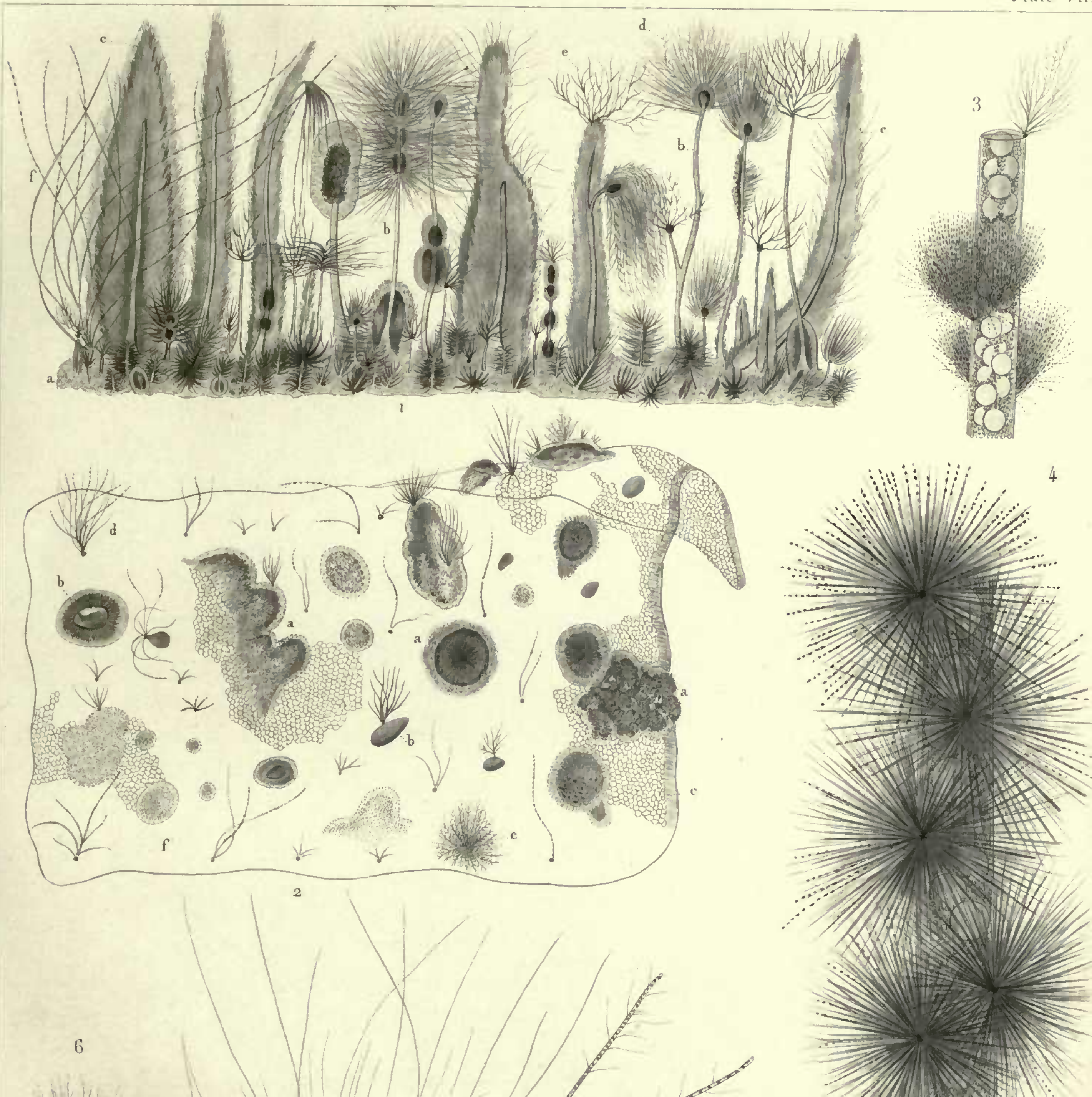

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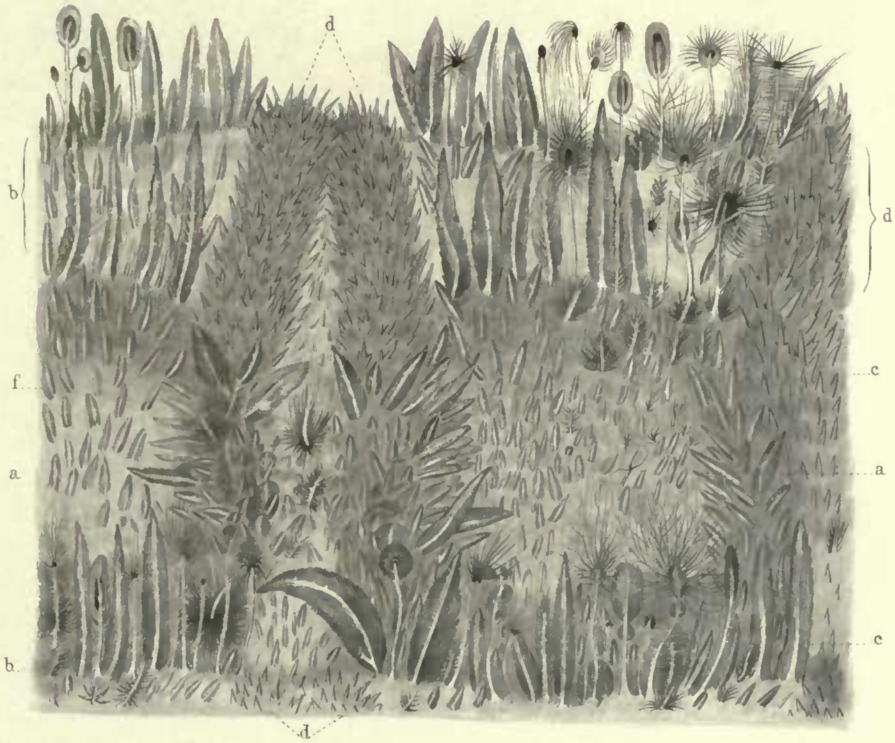

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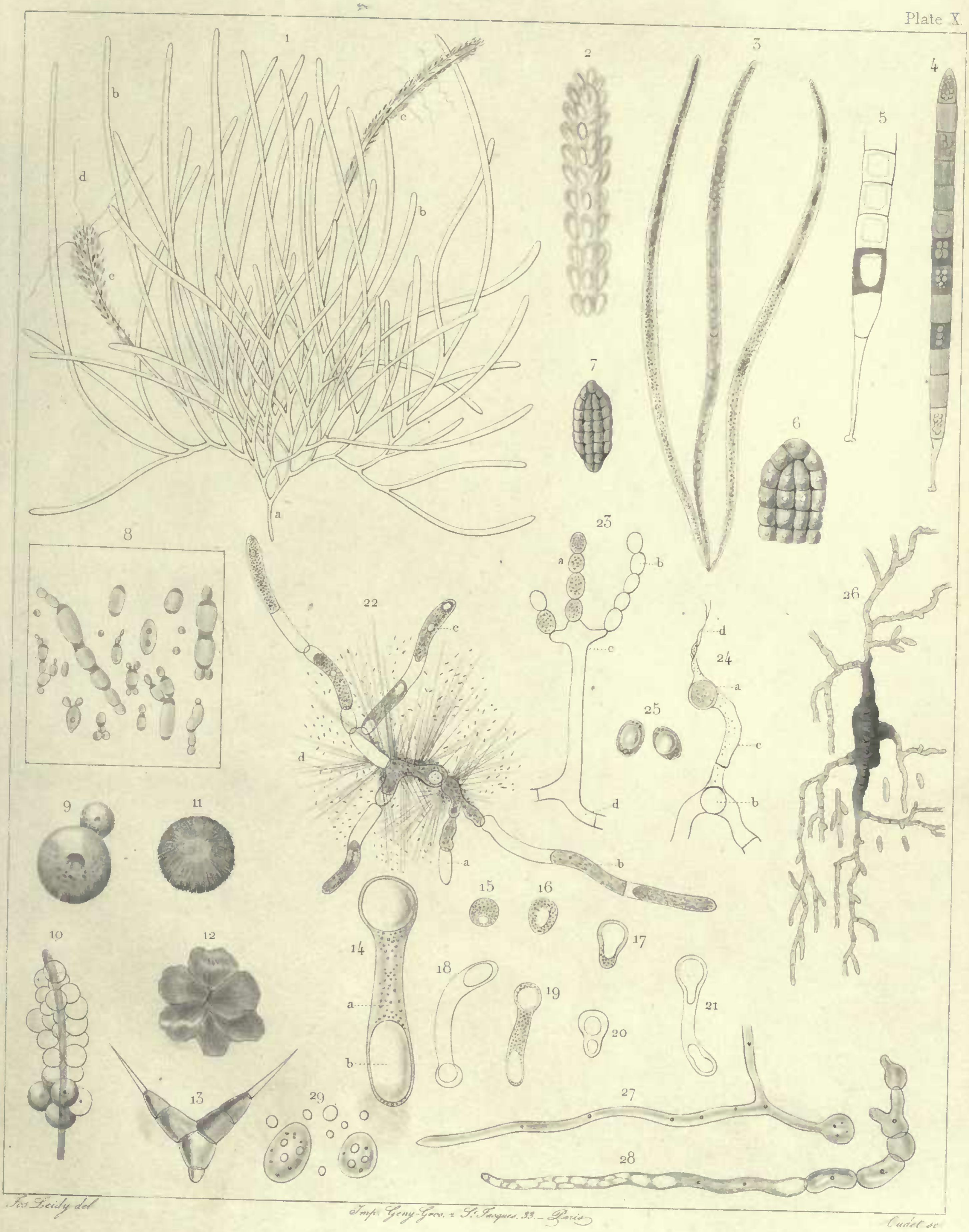

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